REVISED REPORT

Human Health Risk Assessment

Hercules Research Center

Wilmington, Delaware

Revised January 27, 2011

Wo#: 0070857

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1.0 INTRODUCTION

This chapter presents the Human Health Risk Assessment (HHRA) for the Hercules Research Center ("the site"), in order to establish a baseline to evaluate the potential for non-carcinogenic adverse health effects and carcinogenic risk attributable to exposure to on-site soils, on-site ground water, and adjacent off-site sediment and surface water in the Red Clay Creek. U.S. Environmental Protection Agency (USEPA) Region 3- and Delaware Department of Natural Resources and Environmental Control (DNREC)- approved receptor populations evaluated quantitatively in the HHRA included the following: current and future on-site construction worker; current and future on-site industrial worker; current and future hypothetical adjacent off-site adolescent trespasser (Red Clay Creek); and current and future hypothetical future on-site adult, child and lifetime (i.e., child *plus* adult) residents in accordance with USEPA risk assessment guidance (USEPA 2001). Although future residential development of the site is highly unlikely given that the site is active and located on a floodplain, USEPA Region 3/DNREC requested that Hercules evaluate risks posed to hypothetical future on-site residents in the HHRA.

Additionally, although there is no current potable use of untreated on-site ground water, hypothetical future on-site industrial worker exposures and hypothetical future on-site adult and child residents and lifetime resident exposures to untreated on-site ground water as a potable water supply are evaluated quantitatively. Hercules currently obtains their drinking water from a combination of on-site supply wells and from the local municipal water company (Artesian Water Company). The on-site supply wells pump ground water from the bedrock aquifer (not from the overburden aquifer) and is treated on-site prior to distribution. Periodic tap samples collected for VOC analysis have routinely been below detection limits.

The HHRA was conducted by Environmental Resources Management, Inc. (ERM) on behalf of Hercules in accordance with federal USEPA and USEPA Region 3 guidance and consistent with USEPA's *Risk Assessment Guidance for Superfund: Volume I, Human Health Evaluation Manual (Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments)* dated December 2001 (hereafter referred to as *RAGS Part D*).

The HHRA is organized as follows, consistent with the *RAGS Part D* risk assessment structure:

- **Receptor Evaluation**: Populations that may be exposed to the site-related constituents of potential concern (COPCs) selected in the

Hazard Identification step are identified and exposure pathways to these receptors are selected for further evaluation.

- **Hazard Identification**: The analytes detected in the environmental media sampled are identified and the analytical data are summarized. Selection of COPCs is discussed.
- **Exposure Assessment**: The magnitude, frequency and duration of exposure are estimated and the potential chronic intakes (i.e., doses) are quantified.
- **Toxicity Assessment**: The toxicological properties of the COPCs are discussed and the health effects criteria used in the quantitative risk assessment are summarized.
- **Risk Characterization**: Human exposure information and toxicity criteria are integrated to develop estimates of the nature and magnitude of the potential non-carcinogenic hazard and carcinogenic risk to human health.
- **Uncertainty**: Sources of uncertainty in the hazard and risk calculations that may result in an overestimation or underestimation of hazards and risks are discussed.

2.0 RECEPTOR EVALUATION

The Receptor Evaluation identifies exposure pathways and routes by which human receptors may come into contact with the site-related COPCs. The specific steps involved in the Receptor Evaluation include the following:

Characterization of Exposure Setting

- Description of the physical setting
- Identification of potentially-exposed populations (i.e., receptors)

Identification of Exposure Pathways

- Identification of media of concern
- Identification of actual and potential exposure routes

The physical characteristics of the site were studied to identify pathways by which human receptors could potentially be exposed to COPCs at the site. Exposure scenarios to be used in the quantitative HHRA were developed based on demographics, land use, and typical human behavior patterns for such settings.

2.1 IDENTIFICATION OF MEDIA OF CONCERN

The purpose of this step is to identify the media to be evaluated in the HHRA. To qualify for quantitative evaluation, an exposure pathway must include the following four elements (USEPA 1989):

- A source and mechanism of COPC release to the environment;
- A transport medium by which the released COPC may reach a receptor (e.g., soil);
- A point of potential contact of the human receptor with the impacted medium (e.g., individual accesses the site and contacts the impacted soil); and
- An exposure route (e.g., incidental soil ingestion, dermal contact with soil, inhalation of wind-blown particulates).

Potential exposures to site-related COPCs were quantified in the HHRA for the following media:

- On-site soils;

- On-site ground water;
- Adjacent off-site sediments located in Red Clay Creek;
- Adjacent off-site surface water of Red Clay Creek; and
- Air.

In this HHRA, each of the above was considered to be a potential transport medium for COPC migration. On-site soils were screened and evaluated separately for the following four Areas of Concern (AOCs) and four Solid Waste Management Units (SWMUs) investigated during the RFI (Phase I and Phase II).

- AOC B - Runoff Control Area

- AOC D - No. 6 Fuel Oil Spill Area. Soils in AOC D were analyzed for benzene, toluene, ethylbenzene and xylene (BTEX) and total petroleum hydrocarbons (TPH) only. Since there were no positive detections of BTEX and there is no screening level for TPH, soils at AOC D are not quantitatively evaluated.

- AOC E - Pilot Plant Area

- AOC F - Northern Grass Area

- SWMU 4 - Tank Farm Area

- SWMU 7 – Waste Solvent Burner Area

- SWMU 9D - Barrel Storage Area

- SWMU 12 - Train Unloading Area

On-site ground water was evaluated as a single unit, as requested by USEPA Region 3/DNREC as part of the HHRA scoping activities. However, with respect to ground water, it should be noted that formerly only production wells completed in the deep bedrock aquifer were used for sanitary/potable purposes at the facility. These wells were decommissioned and abandoned in March 2008.

It is important to note that USEPA requires that the analytical results from overburden aquifer as well as the bedrock aquifer samples from monitoring wells be evaluated for routine exposure to hypothetical receptor populations. These wells are all constructed as monitoring wells, not drinking water wells. Contact with unfinished ground water is not a complete exposure pathway. However, in order to complete this risk assessment according to USEPA requirements, ERM considered exposure to hypothetical future on-site receptor populations.

2.2 IDENTIFICATION OF RECEPTOR POPULATIONS OF CONCERN AND POTENTIAL EXPOSURE PATHWAYS

The physical characteristics of the site and characteristics of the human population on and near the site were evaluated to determine which parameters might influence exposure to site COPCs, and to identify possible exposure pathways. This section focuses on actual and potential receptors that could be exposed to site COPCs.

Demographics and land use were evaluated to assess present and potential future populations living, working or otherwise spending time at or in the area of the site. The purpose of this analysis was to assess the likelihood of exposure to site constituents by various populations, including sensitive subpopulations.

Multiple exposure scenarios were developed to evaluate the current and future use of the site, as shown in Table 1 in Attachments A through I. These exposure scenarios were proposed by Hercules as being appropriate to evaluate actual and potential receptor populations that might be exposed to site-related COPCs and were approved by USEPA Region 3/DNREC prior to Hercules' conducting the HHRA.

2.2.1 *Current and Future On-Site Construction Worker Exposure*

ERM considered routine exposure to current and future on-site construction workers to include incidental ingestion of soil, inhalation of wind-blown particulates and vapors from soil and dermal contact with soil during invasive construction activities.

Because the depth of the ground water table at the site is shallow [i.e., average four (4.17) feet below ground surface], construction worker exposure to ground water was considered a potential exposure pathway while undertaking invasive activities. The potential for ground water to theoretically "pool" at the soil surface in an excavation area could result in construction worker exposure to ground water "as if" it were surface water. Therefore, exposure to current and future on-site construction workers includes the incidental ingestion of ground water, inhalation of vapors from ground water and dermal contact with ground water during invasive construction activities. Exposure to ground water by current and future on-site construction workers was treated in the same manner as a surface water exposure.

Construction workers were assumed to not be undertaking invasive activities within the Red Clay Creek stream bed, so no exposures to sediment or surface water were anticipated. Therefore, exposures to sediment and surface water were not evaluated quantitatively in the HHRA for the current and future on-site construction worker.

2.2.2 *Current and Future On-Site Industrial Worker Exposure*

ERM considered routine exposure to current and future on-site industrial workers to include incidental ingestion of soil, inhalation of wind-blown particulates and vapors from soil and dermal contact with soil during day-to-day activities on-site. Based upon current and anticipated future on-site industrial worker activity patterns, it was assumed that the industrial worker would not be routinely engaged in invasive digging activities and that only incidental direct contact with soils would occur in an ordinary working day.

It is important to note that USEPA requires that the results from monitoring well analyses be evaluated for routine exposure to future on-site industrial workers. These wells are all constructed as monitoring wells, not drinking water wells. Contact with unfinished ground water is not a complete exposure pathway. However, in order to complete this risk assessment according to USEPA requirements, ERM considered exposure to future on-site industrial workers to include ingestion of on-site ground water as a potable water source, as well as inhalation of volatiles from on–site ground water while showering and dermal contact with on-site ground water while showering.

Industrial workers do not contact Red Clay Creek sediment or surface water. Therefore, exposures to sediment and surface water were not evaluated quantitatively in the HHRA for the current and future on-site industrial worker.

2.2.3 *Current and Future Hypothetical On-Site Adolescent Trespasser Exposure*

Adolescent trespasser exposure to on-site soil and ground water is not a complete exposure pathway. The site is completely fenced, patrolled, and monitored 24 hours a day, 7 days a week through the use of security personnel and security cameras. As a result, exposure to on-site soil and ground water was not evaluated quantitatively in the HHRA for the current and future hypothetical on-site adolescent trespasser.

ERM considered potential exposure to current and future hypothetical adjacent off-site adolescent trespassers in Red Clay Creek to include incidental ingestion of sediment, inhalation of wind-blown particulates from dry stream bed sediment, inhalation of vapors from sediment, and dermal contact with sediment while wading in Red Clay Creek. Potential exposure pathways also included incidental ingestion of surface water, inhalation of vapors from surface water and dermal contact with surface water while wading in Red Clay Creek. At USEPA and DNREC's request, surface water exposures in Red Clay Creek were evaluated using the most current ground water data collected from piezometers located along the bank of the Red Clay Creek where on-site ground water may intercept surface water in Red Clay Creek.

2.2.4 *Current Off-Site and Future On-Site Adult Resident, Child Resident and Lifetime Resident Exposure*

Given that the site is an active industrial facility, exposure to on-site soils and ground water was considered to be an incomplete exposure pathway for a current on-site adult residents, child residents and lifetime residents based on current site use and conditions. Consequently, exposure to on-site soils and ground water was not evaluated quantitatively in the HHRA for current residential receptors. However, current off-site adult residents, child residents and lifetime residents may include exposure to sediment and surface water in Red Clay Creek. Therefore, the incidental ingestion of sediment, inhalation of wind-blown particulates from dry stream bed sediment, inhalation of vapors from sediment, and dermal contact with sediment while wading in Red Clay Creek was quantitatively evaluated. In addition, the incidental ingestion of surface water, inhalation of vapors from surface water and dermal contact with surface water while wading in Red Clay Creek was quantitatively evaluated. At USEPA and DNREC's request, surface water exposures in Red Clay Creek were evaluated using the most current ground water data collected from piezometers located along the bank of the Red Clay Creek where on-site ground water may intercept surface water in Red Clay Creek.

While the site is expected to remain industrial into the foreseeable future, at USEPA and DNREC's request, a quantitative evaluation for hypothetical future on-site residential exposure to on-site soils and ground water, and sediment and surface water in Red Clay Creek is provided. ERM considered exposure to future hypothetical on-site residential receptors to include ingestion of on-site ground water as a potable water source as well as inhalation of volatiles from on-site ground water while showering (for adult and lifetime residents) and dermal contact with on-site ground water while showering (for adult and lifetime residents) or bathing (for child residents). Exposure to future hypothetical on-site residential receptors also includes the incidental ingestion of soil, inhalation of wind-blown particulates, and vapors from soil, and dermal contact with soil. ERM also assumed that the hypothetical future on-site adult resident might contact sediment and surface water in Red Clay Creek, which was evaluated in the same manner as the current off-site residential exposures described above.

2.2.5 *Quantitative Risk Assessment Calculations - Presentation Format*

Because there are multiple soil SWMUs/AOCs, all quantitative risk calculation tables were organized by receptor population and are included as separate Attachments to this document for reference. Tables within each Attachment are numbered according to *RAGS Part D* guidance, which prescribes the following numeric order for presentation of the risk information/calculations.

Attachment Table 1: Selection of Exposure Pathways

Attachment Table 2: Occurrence, Distribution, and Selection of COPCs

Attachment Table 3: Exposure Point Concentration Summary

Attachment Table 4: Values Used for Daily Intake Calculations

Attachment Table 5: Non-Cancer Toxicity Data

Attachment Table 6: Cancer Toxicity Data

Attachment Table 7: Calculation of Chemical Non-Cancer Hazards

Attachment Table 8: Calculation of Chemical Cancer Risks

Attachment Table 9: Summary of Receptor Risk and Hazards for COPCs

Attachment Table 10: Risk Summary

A list of each Attachment and its contents is presented in report Table 1. All subsequent sections of this HHRA will reference the appropriate Attachment when describing the risk calculations for a specific receptor population.

3.0 HAZARD IDENTIFICATION

During this step, the identification of constituents of potential concern was completed utilizing USEPA Region 3 guidance, *"Selecting Exposure Routes and Contaminants of Concern by Risk-Based Screening"* (USEPA Region 3, 1993). In the first step, a screening analysis was performed, in which constituent concentrations were compared to published risk-based concentrations (RBCs) developed by USEPA Region 3 (USEPA Region 3, 6 April 2007). Procedures used to identify COPCs for each medium of concern are described in the following sections.

3.1 SELECTION OF CONSTITUENTS OF POTENTIAL CONCERN

3.1.1 Selection Methodology

This section describes the methodology used to select COPCs for the HHRA for all media of concern evaluated in the HHRA. The selected COPCs are a subset of the total list of analytes detected, and these COPCs were deemed most likely to contribute to any human health hazard or risk at the site. COPCs were selected for on-site soils, on-site ground water, Red Clay Creek sediments, and Red Clay Creek surface water (as represented by piezometer data).

The following hierarchy, listed in descending order of priority, was used to exclude analytes from the HHRA:

- The analyte was never detected in any sample for a given medium (i.e., all data were qualified with "U"), consistent with *RAGS Part A* (USEPA 1989);
- Essential nutrients, consistent with *RAGS Part A* (USEPA 1989);
- Analytes with maximum concentrations below USEPA Region 3's Risk-Based Concentration or other applicable screening value for a given medium, consistent with USEPA Region 3's *Selecting Exposure Routes and Contaminants of Concern by Risk-Based Screening* (1993); and
- Frequency of detection less than 5%, consistent with *RAGS Part A* (USEPA 1989).

The COPCs retained were selected qualitatively based primarily on analyte concentration. The conservative selection process described below favored the inclusion of analytes in the HHRA rather than the selection of only a few indicator constituents.

Analytes not detected in a given medium (e.g., data all qualified as "U") were eliminated from further consideration (USEPA 1989) in that medium, since the reported non-detected concentrations were below the USEPA Region 3 RBCs. The USEPA Region 3 RBCs are calculated to be protective of receptors with daily direct contact ingestion exposures to soil or ground water, using typical USEPA default exposure assumptions. Next, the maximum concentrations detected at the site were compared to USEPA Region 3 RBCs. RBCs for non-carcinogens were based upon a Hazard Index of 0.1 while RBCs for carcinogens were based upon a Cancer Risk of $1x10^{-6}$ in this screening step (USEPA Region 3 1993).

Where RBCs were not available, RBCs for constituents of presumed similar toxicity and known similar chemical structure were used as surrogates. The surrogate RBCs used in this assessment included the following:

- acenaphthylene and benzo(g,h,i)perylene were based upon acenaphthene;
- phenanthrene was based upon anthracene;
- bis(2-chloroethoxy)methane was based upon bis(chloromethyl)ether;
- alpha-Chlordane were based upon Chlordane;
- chromium was based upon chromium (VI);
- dichloroethenes (total) were based upon 1,1-dichloroethene;
- *cis*- and *trans*-1,3-dichloropropene were based upon 1,3-dichloropropene;
- alpha- and beta-Endosulfan and Endosulfan Sulfate were based upon Endosulfan;
- Endrin Aldehyde and Endrin Ketone were based upon Endrin;
- cyanide (total) was based upon free cyanide;
- 2-hexanone was based on cyclohexanone;
- mercury was based upon mercuric chloride;

- 2-nitrophenol and 4-nitrophenol were based on 2,4-dinitrophenol; and

- dichlorofluoromethane was based upon trichlorofluoromethane.

Due to their low toxicities, the essential human nutrients calcium, magnesium, potassium and sodium were eliminated from further consideration as COPCs (USEPA 1989; 2001).

Surface and subsurface soil data from 0 – 10 feet were combined for use in the selection of COPCs for soil in the HHRA for the evaluation of industrial/construction worker and residential exposures (per DNREC request, letter dated 13 September 2005). On-site soils were screened and evaluated separately for each SWMU/AOC investigated during the RFI (Phase I and Phase II).

In accordance with the Phase 2 RFI Work Plan, select soil samples were analyzed for the full suite of dioxin and furan congeners. Similarly, select soil samples were analyzed for the full suite of polychlorinated biphenyl (PCB) congeners. In samples where congener data for dioxins/furans and PCBs were available, the data were treated according to USEPA guidance *Exposure and Human Health Reassessment of 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) and Related Compounds - Chapter 9. Toxic Equivalency Factors (TEFs) for Dioxin and Related Compounds* (NCEA-I-0836, December 2003). Available dioxin/furan and PCB congener TEFs were multiplied by the detected concentration (for positively detected congeners) and/or one-half the detection limit (for non-detected congeners) and summed to calculate a Toxicity Equivalency Concentration (TEC). The TEC was then used to represent the total TCDD concentration for that sample. TEC calculations for dioxin/furan congeners and PCB congeners are presented in report Tables 2 and 3, respectively. In addition, the bottom of Table 3 presents the sum of the TCDD TECs and dioxin-like PCB TECs in samples where both sets of data were available. Total TCDD TECs were compared to the RBC for TCDD. Table 3a presents the sum of the non-dioxin-like PCB congeners, which were summed and compared to the RBC for total PCBs.

On-site ground water samples were evaluated as a single bearing unit, as approved by USEPA Region 3 and DNREC as part of the HHRA scoping activities. The ground water data set evaluated in the HHRA included all available data from permanent monitoring wells from 2002 through 2006. Temporary well data collected prior to 2002 was not included in the HHRA because permanent monitoring wells were installed at these locations and re-sampled multiple times beginning in 2002.

No surface water samples in Red Clay Creek were collected during the Phase 2 remedial investigation; therefore, at USEPA and DNREC's request, surface water exposures in Red Clay Creek were evaluated using the most current ground water data collected from piezometers located along the bank of the Red Clay Creek where on-site ground water may mix with the surface water in Red Clay Creek. This approach is highly conservative given that constituents in ground water collected from piezometers would be subject to significant dilution upon discharge to Red Clay Creek. In addition, historical data exist (Phase 1 RI) that would indicate that COPCs are not present in surface water at concentrations that would be at or above a concentration of regulatory concern.

Sediment samples collected from Red Clay Creek adjacent to or downgradient of the site during the RFI (Phase I and Phase II) were included in the sediment screening analysis. Sediment samples collected to reflect upgradient or background conditions were omitted from the selection of COPCs for sediment. Sediment samples collected by ERM only were included in the dataset.

In the selection of COPCs for sediment, the USEPA Region 3 RBCs for residential soil were multiplied by a factor of 10 to account for the assumption that exposure to Red Clay Creek sediments would occur only rarely and that prolonged exposure to any COPCs would not be anticipated. In the case of surface water (piezometer data), the screening level used was the lower of the DNREC Surface Water Quality Criteria or the USEPA Region 3 RBCs for tap water. Similar to screening levels for sediment, USEPA Region 3 RBCs for tap water were multiplied by a factor of 10 to account for the fact that surface water is not currently, nor is it anticipated that in the future surface water will be used as a potable water source. Contact with sediment and surface water was expected to occur with limited frequency, if at all.

3.1.2 *Summary of Constituents of Potential Concern*

The results of this screening process are presented in Tables 2.1 through 2.2 or 2.1 through 2.4 in each Attachment. These tables list the analytes evaluated, the minimum and maximum detected concentrations, the location of the maximum detected concentration, the detection frequency, the range of analytical detection limits, the concentration used for screening (i.e., the maximum detected concentration for those constituents with at least one positive detection), the site-specific background concentration, the screening toxicity value (i.e., the USEPA Region 3 RBC Table value), potential ARAR/TBC Values, the result of the screening step (designated as the "COPC Flag") and the rationale for including or excluding the analyte in the quantitative HHRA. Those COPCs retained for further quantitative evaluation in the HHRA are shaded.

Detection limits for soil samples analyzed by a fixed-based laboratory ("Fixed Lab") and the ERM-FAST laboratory ("Mobile Lab") are presented separately because different analytical methods were used on the samples. For metal results, in particular, Mobile Lab detection limits can be as much as an order of magnitude higher than Fixed Lab detection limits.

The following table summarizes the sediment contaminants detected in Red Clay Creek at concentrations exceeding adjusted USEPA Region 3 RBCs for residential soils and/or soil screening levels:

Red Clay Creek Sediment COPCs	Location of Maximum
Arsenic	SWMU-8/9C/SED-4

The following table summarizes the surface water contaminants detected in piezometers located along Red Clay Creek, at concentrations exceeding the lower of the adjusted USEPA Region 3 RBCs for tap water or Delaware Ambient Water Quality Criteria:

Red Clay Creek Surface Water COPCs (Piezometer Data)	Location of Maximum
1,4-Dichlorobenzene	CP-3
4,4-DDD	CP-3
4,4-DDT	CP-4
alpha-BHC	CP-3
Arsenic	CP-4
Benzene	CP-4
Beryllium	CP-1
beta-BHC	CP-3
Chlorobenzene	CP-4
cis-1,2-Dichloroethene	CP-2
Heptachlor	CP-2
Indeno(1,2,3-cd)pyrene	CP-1
Iron	CP-1
Manganese	CP-2
Tetrachloroethene	CP-3
Trichloroethene	CP-2
Vanadium	CP-1
Vinyl Chloride	CP-2

The following table summarizes the ground water contaminants detected in on-site ground water at concentrations exceeding USEPA Region 3 RBCs for tap water:

Ground Water COPCs	Location of Maximum
4,4-DDD	AOC-B/MW-2
Aluminum	MW-5S
Arsenic	SWMU-4/MW-1
Arsenic (Dissolved)	AOC-B/MW-1
Benzene	MW-7
beta-BHC	MW-7
Chlorobenzene	MW-9S
Chromium	MW-5S
cis-1,2-Dichloroethene	SWMU-9A/15/MW-3

Indeno(1,2,3-cd)pyrene	AOC-B/MW-1
Iron	MW-9S
Lead	MW-8
Manganese	MW-9S
Manganese (Dissolved)	SWMU-9A/15/MW-3
Nickel	AOC-B/MW-2
Tetrachloroethene	MW-6D
Thallium	MW-4S
Trichloroethene	MW-6S
Vanadium	MW-5S
Vanadium (Dissolved)	SWMU-9A/15/MW-4
Vinyl Chloride	SWMU-9A/15/MW-3

The following table summarizes the soil contaminants detected in on-site soils at concentrations exceeding USEPA Region 3 RBCs for industrial soils and/or soil screening levels:

AOC B Soil COPCs	**Location of Maximum**
4,4-DDT	AOC-B/SB-1
Aroclor 1254	AOC-B/SB-1
Aroclor 1260	AOC-B/SB-1
Arsenic	AOC-B/SB-2
Iron	AOC-B/SB-2
Total PCB Non-Dioxin-Like Congeners	AOC-B/SS-6
Total TCDD TEC	AOC-B/SS-6
Vanadium	AOC-B/SB-1
AOC E Soil COPCs	**Location of Maximum**
Aroclor 1254	AOC-E/SS-4
Aroclor 1260	AOC-E/SS-4
Arsenic	AOC-E/SB-12
Dieldrin	AOC-E/SS-4
Total PCB Non-Dioxin-Like Congeners	AOC-E/SS-1
Total TCDD TEC	AOC-E/SS-1
Vanadium	AOC-E/SB-12
AOC F Soil COPCs	**Location of Maximum**
Aroclor 1260	AOC-F/SD-2
Arsenic	AOC-F/SS-15
Total PCB Non-Dioxin-Like Congeners	AOC-F/SS-21
Total TCDD TEC	AOC-F/SS-21
SWMU 4 Soil COPCs	**Location of Maximum**
Arsenic	SWMU-4/SB-11
Benzene	SWMU-4/SB-7
Total PCB Non-Dioxin-Like Congeners	SWMU-4/SS-11
Total TCDD TEC	SWMU-4/SS-11
SWMU 7 Soil COPCs	**Location of Maximum**
Total TCDD TEC	SWMU-7/SS-7
SWMU 9D Soil COPCs	**Location of Maximum**
4,4-DDT	SWMU-9D/SB-1
Aroclor 1254	SWMU-9D/SS-2
Arsenic	SWMU-9D/SB-1
Chromium	SWMU-9D/SB-5
Iron	SWMU-9D/SB-3
Total TCDD TEC	SWMU-9D/SS-6
Vanadium	SWMU-9D/SB-2,SB-3
SWMU 12 Soil COPCs	**Location of Maximum**
Aroclor 1254	SWMU-12/SS-1
Aroclor 1260	SWMU-12/SB-7
Arsenic	SWMU-12/SB-5
Manganese	SWMU-12/SB-4
Total PCB Non-Dioxin-Like Congeners	SWMU-12/SS-9
Total TCDD TEC	SWMU-12/SS-9
Vanadium	SWMU-12/SB-3

The following table summarizes the soil contaminants detected in on-site soils at concentrations exceeding USEPA Region 3 RBCs for residential soils and/or soil screening levels:

AOC B Soil COPCs	**Location of Maximum**
4,4-DDE	AOC-B/SB-1
4,4-DDT	AOC-B/SB-1
Aluminum	AOC-B/SB-3
Aroclor 1254	AOC-B/SB-1
Aroclor 1260	AOC-B/SB-1
Arsenic	AOC-B/SB-2
Cadmium	AOC-B/3A
Chromium	AOC-B/SB-2
Iron	AOC-B/SB-2
Manganese	AOC-B/2A
MCPA	AOC-B/SS-5
Thallium	AOC-B/SB-2
Total PCB Non-Dioxin-Like Congeners	AOC-B/SS-6
Total TCDD TEC	AOC-B/SS-6
Toxaphene	AOC-B/2A
Vanadium	AOC-B/SB-1
AOC E Soil COPCs	**Location of Maximum**
4,4-DDT	AOC-E/SB-9
Aluminum	AOC-E/SB-12
Aroclor 1254	AOC-E/SS-4
Aroclor 1260	AOC-E/SS-4
Arsenic	AOC-E/SB-12
Chromium	AOC-E/SB-12
Dieldrin	AOC-E/SS-4
Iron	AOC-E/SB-12
Manganese	AOC-E/SB-12
Thallium	AOC-E/SB-12
Total PCB Non-Dioxin-Like Congeners	AOC-E/SS-1
Total TCDD TEC	AOC-E/SS-1
Vanadium	AOC-E/SB-12
AOC F Soil COPCs	**Location of Maximum**
4,4'-DDT	AOC-F/SS-2
Aluminum	AOC-F/SS-14
Aroclor 1254	AOC-F/SD-5
Aroclor 1260	AOC-F/SD-2
Arsenic	AOC-F/SS-15
Benzo(a)anthracene	AOC-F/SS-7
Benzo(a)pyrene	AOC-F/SS-7
Benzo(b)fluoranthene	AOC-F/SS-7
Chromium	AOC-F/SS-1
Dibenz(a,h)anthracene	AOC-F/SS-7
Indeno(1,2,3-cd)pyrene	AOC-F/SS-7
Iron	AOC-F/SS-8
Manganese	AOC-F/SS-12
Total PCB Non-Dioxin-Like Congeners	AOC-F/SS-21
Total TCDD TEC	AOC-F/SD-21
Vanadium	AOC-F/SS-8
SWMU 4 Soil COPCs	**Location of Maximum**
Arsenic	SWMU-4/SB-13
Aluminum	SWMU-4/SB-11
Benzene	SWMU-4/SB-7
Benzo(a)pyrene	SWMU-4/SB-13
Chromium	SWMU-4/SB-10
Iron	SWMU-4/SB-10
Manganese	SWMU-4/SB-12
Thallium	SWMU-4/SB-12
Total PCB Non-Dioxin-Like Congeners	SWMU-4/SS-11
Total TCDD TEC	SWMU-4/SS-11
Vanadium	SWMU-4/SB-13

SWMU 7 Soil COPCs	Location of Maximum
Total TCDD TEC	SWMU-7/SS-7
SWMU 9D Soil COPCs	**Location of Maximum**
4,4-DDD	SWMU-9D/SB-1
4,4-DDT	SWMU-9D/SS-1
4,4-DDE	SWMU-9D/SB-1
Aluminum	SWMU-9D/SB-2
Aroclor 1254	SWMU-9D/SB-2
Aroclor 1260	SWMU-9D/SB-2
Arsenic	SWMU-9D/SB-1
Chromium	SWMU-9D/SB-5
Copper	SWMU-9D/SB-5
Iron	SWMU-9D/SB-3
Manganese	SWMU-9D/SB-3
Total PCB Non-Dioxin-Like Congeners	SWMU-9D/SS-5
Total TCDD TEC	SWMU-9D/SS-6
Vanadium	SWMU-9D/SB-2,SB-3
SWMU 12 Soil COPCs	**Location of Maximum**
Aroclor 1254	SWMU-12/SS-1
Aroclor 1260	SWMU-12/SB-7
Aluminum	SWMU-12/SS-2
Arsenic	SWMU-12/SB-5
Benzo(a)anthracene	SWMU-12/SS-1
Benzo(a)pyrene	SWMU-12/SS-1
Benzo(b)fluoranthene	SWMU-12/SS-1
Chromium	SWMU-12/3A
Iron	SWMU-12/SB-5
Manganese	SWMU-12/SB-4
Total PCB Non-Dioxin-Like Congeners	SWMU-12/SS-9
Total TCDD TEC	SWMU-12/SS-9
Vanadium	SWMU-12/SB-3

3.2 STATISTICAL DATA EVALUATION AND SELECTION OF EXPOSURE POINT CONCENTRATIONS

Validation qualifiers were treated according to USEPA guidance (USEPA 1989). Non-detection results ("U" qualifiers) were included only if other results for a given constituent in a particular medium indicated the constituent was present. In these instances, half the reported sample quantitation limit was used. This procedure is described further below. Estimated results, usually indicated by a "J" qualifier, were included in the data evaluation. Detected concentrations qualified with a "K" or "L" were also included in the data evaluation. At the request of USEPA Region 3, concentrations qualified with a "B" were treated as non-detects. In these instances, half the reported "B" qualified value was used.

The analytical results for duplicate samples were averaged in the following manner in accordance with USEPA guidance (USEPA 1989). The resulting value was the arithmetic mean of the detected concentrations if the analyte was detected in both samples or the arithmetic mean of the reported detection limits if both samples were non-detects. If one of the duplicate samples was a positive detect and the other a non-detect, the detected result was used to represent the sample (i.e., the samples were not averaged and the detection limit was not used).

In accordance with the HHRA Work Plan (22 June 2005), the exposure point concentration (EPC) was calculated as the Upper Confidence Limit (UCL) on the mean of the analytical data, as recommended and calculated by the USEPA software program *ProUCL* (Version 3.00.02).

Summary statistics for all COPCs retained for each receptor population evaluated quantitatively in the HHRA in each medium are presented on Table 3.1 of each Attachment. These tables list the COPCs; the arithmetic mean of the data; the *ProUCL*-recommended UCL; the EPC value, statistic and rationale for the reasonable maximum exposure (RME) evaluation; and the EPC value, statistic and rationale for the central tendency (CT) evaluation. The EPC was defined as the lower of the *ProUCL*-recommended UCL or the maximum-detected concentration for each COPC.

Table 3.1 and 3.3 in each Attachment presents the EPCs used to evaluate ingestion and dermal contact with sediment, surface water (piezometer data), on-site ground water and on-site soils. Table 3.2 in each Attachment presents the EPCs used to calculate the modeled airborne particulate and/or vapor concentrations shown on Tables 3.2 A and/or 3.2 B. In the case of solid media (sediment, soil), Table 3.2 A presents the medium-specific EPCs in air used to evaluate inhalation exposure to particulates and Table 3.2 B presents the medium-specific EPCs in air used to evaluate inhalation exposure to vapors. Table 3.2 C summarizes the route-specific EPCs in air.

In the case of inhalation exposure of ground water to the construction worker (Attachment E), it was assumed that vapors from organic COPCs in ground water could move through the soil column into ambient air within an excavation. Chemical-specific volatilization factors from ground water to ambient air were calculated using ASTM Standard Guide for Risk-Based Corrective Action (E 2081-00, 2000), which utilizes the following equation (equation parameters are defined in the table below):

$VF_{gw,amb} = [H_{eff}/(1+((DF_{amb}*L_{gw})/D_{eff,ws})]$ Equation (1)

Where:

$DF_{amb} = U_{air}*W*d_a/A$ (conservatively assume source-zone area, $A=W^{\wedge 2}$)

Thus Equation (1) becomes:

$VF_{gw,amb} = [H_{eff}/(1+((U_{air}*d_a*L_{gw})/(W*D_{eff,ws}))]$

Where:

$D_{eff,ws} = L_{gw}/((h_v/D_{eff,vad})+(h_{cap}/D_{eff,cap}))$, and

$D_{eff,vad} = D_{air}*(\theta_{avad}\wedge a/\theta_t\wedge b)+D_{wat}*(\theta_{wvad}\wedge a/H_{eff}*\theta_t\wedge b)$, and

$D_{eff,cap} = D_{air}*(\theta_{acap}\wedge a/\theta_t\wedge b)+D_{wat}*(\theta_{wcap}\wedge a/H_{eff}*\theta_t\wedge b)$

The following table presents the input parameters used in the equations above to calculate volatilization factors from ground water to ambient air.

Input Variables:	Value	Units
Volatilization Factor from Ground Water to Ambient Air , $VF_{gw,amb}$	Calculated	cm/m³-air/cm/L-water
Dispersion Factor for Ambient Air, DF_{amb}	Calculated	cm/s
Effective Diffusion Coefficient between Ground Water & Soil, $D_{eff,ws}$	Calculated	cm^2/s
Effective Diffusion Coefficient in Soil based on Vapor, $D_{eff,vad}$	Calculated	cm^2/s
Effective Diffusion Coefficient through Capillary Fringe, $D_{eff,cap}$	Calculated	cm^2/s
Effective Henry's Law Coefficient, H_{eff}	Chemical-specific	mg/L water/mg/L air
Diffusion Coefficient in Air, D_{air}	Chemical-specific	cm^2/s
Diffusion Coefficient in Water, D_{wat}	Chemical-specific	cm^2/s
Wind speed above Ground Surface in Ambient Mixing Zone, U_{air}	2.25E+02	cm/s
Ambient Air Mixing Zone Height, d_a	2.00E+02	cm
Depth to Ground Water, L_{gw}	1.27E+02	cm
Width of Source Area Parallel to Fluid Flow, W	6.10E+02	cm
Volumetric Ratio Numerator Exponent, a	3.33E+00	unitless
Volumetric Ratio Denominator Exponent, b	2.00E+00	unitless
Thickness of Capillary Fringe, h_{cap}	5.00E+00	cm
Thickness of Vadose Zone, h_v	1.22E+02	cm
Volumetric Air Content in Capillary Fringe Soils, θ_{acap}	3.80E-02	cm^3 air/cm^3 total volume
Volumetric Air Content in Vadose Zone Soils, θ_{avad}	2.60E-01	cm^3 air/cm^3 total volume
Total Soil Porosity, θ_t	3.80E-01	cm^3 air/cm^3 soil
Volumetric Water Content in Capillary Fringe Soils, θ_{wcap}	3.42E-01	cm^3 water/cm^3 total volume
Volumetric Water Content in Vadose Zone Soils, θ_{wvad}	1.20E-01	cm^3 water/cm^3 total volume

Site-specific input parameters are limited to the width of the source area parallel to ground water flow (W) and the depth to ground water (L_{gw}). The site-wide average depth to ground water was used for L_{gw}, which was 4.12 feet (1.27E+02 centimeters). The average length of an excavation was assumed to be 20 feet (6.1E+02 centimeters), based on professional judgment. All other input parameters were conservative default values presented in the ASTM Standard Guide for Risk-Based Corrective Action (E 2081-00, 2000). Attachment E, Table 3.2 A presents the medium-specific EPCs in air used to evaluate inhalation exposure to vapors from ground water to the construction worker engaged in excavation activities.

In the case of surface water, Attachments A, B, and C, Table 3.4 presents the medium-specific EPCs for ambient air used to estimate potential exposures to COPCs in surface water that may volatilize and subsequently be inhaled. This process consisted of two steps: calculation of COPC emission rates and estimation of ambient air concentrations. Each step is discussed below. Estimation of the emission rate of volatile organic COPCs from water was made following the methods presented in *Superfund Exposure Assessment Manual* (SEAM; USEPA, 1988). This method was developed by Mackay and Leinonen, and relates the emission rate to an overall mass transfer coefficient, as shown below:

$$E_i = K_i \times C_s \times A$$

Where:

E_i	=	Emission Rate (mg/second)
K_i	=	Overall Mass Transfer Coefficient (cm/second)
C_s	=	Contaminant Liquid Phase Concentration (mg/cm^3)
A	=	Area (cm^2)

Emission rates were developed for the adolescent trespasser, residential adult, and residential child wading in or near the Red Clay Creek. The area (A) utilized for these receptor populations was based on an assumed area of the Red Clay Creek source area. It was estimated that the source length was equivalent to the distance between the most upstream and downstream piezometers located along the bank of Red Clay Creek where constituent concentrations were present in excess of screening toxicity values (CP-1 and CP-4, or 440 feet), and one-half of the approximate width of Red Clay Creek (35 feet); this represents an area of 15,400 ft^2 or 1.43E+07 square centimeters.

The overall mass transfer coefficient is calculated as follows:

$$K_i^{-1} = K_{iL}^{-1} + ((R \times T)/(H_i \times K_{iG}))$$

Where:

K_{iL}	=	Liquid Phase Mass Transfer Coefficient (cm/second; chemical-specific)
R	=	Ideal Gas Law Constant (8.2 x 10^{-5} atm-m^3/mole-°K)
T	=	Temperature (298 °K)
H_i	=	Henry's Law Constant for Compound i (atm-m^3/mole)
K_{iG}	=	Gas Phase Mass Transfer Coefficient (cm/second; chemical-specific)

K_{iL} and K_{iG} for constituent i are estimated from measured values for known constituents (i.e., oxygen and water vapor) as follows:

K_{iL} = $(MW_{O2}/MW_i)^{0.5} \times (T/298) \times (k_L, O2)$
K_{iG} = $(MW_{H2O}/MW_i)^{0.335} \times (T/298)^{1.005} \times (k_{iG}, O2)$

Where:

MW_{O2}	=	Molecular Weight of Oxygen (32 g/mole)
MW_{H2O}	=	Molecular Weight of Water (18 g/mole)
MW_i	=	Molecular Weight of Compound i (g/mole)
T	=	Temperature (298 °K)
k_L, O_2	=	Liquid Phase Mass Transfer Coefficient for Oxygen at 25°C (0.0061 cm/second; L. Thibodeaux, 1979)
k_{iG}, O_2	=	Gas Phase Mass Transfer Coefficient for Water Vapor at 25°C (0.833 cm/second; L. Thibodeaux, 1979)

Emission rates were calculated for volatile COPCs in surface water (using piezometer data), and the results of these calculations are presented in Attachments A, B, and C in Table 3.4 A. Ambient air concentrations of volatile organic COPCs were then modeled using these emission rates to evaluate potential exposures to these constituents via inhalation. To provide ambient air concentrations for constituents volatilizing from water, a simple box model was used to simulate constituent dispersion. The box model allows estimation of ambient air concentrations within a defined space, as follows:

$$C_a = \frac{E_i}{LS \times V \times MH}$$

Where:

C_a	=	Ambient Air Concentration (mg/m^3)
E_i	=	Total Emission Rate for the area (mg/second)
LS	=	Length of side perpendicular to the wind (45 meters)
V	=	Average Wind Speed (meters/second)
MH	=	Mixing Height before being inhaled (meters)

This model conservatively assumes a constant emission rate, regardless of temperature, precipitation, etc. The LS term is a default value which assumes a length equal to the square root of a typical residential lot. This was considered a reasonable assumption for this risk assessment. A default wind speed of 2.25 meters/second (USEPA, 1991) was used, and the height of the box was assumed to the average height of an adult, 2 meters.

The resultant ambient air concentrations, presented in Attachments A, B, and C in Table 3.4 A, were used as the EPCs for evaluation of inhalation exposures from volatile constituents of potential concern in surface water (piezometer data) for the adolescent trespasser, residential adult, and residential child wading in or near the Red Clay Creek.

4.0 EXPOSURE ASSESSMENT

In the Exposure Assessment, ERM evaluated the likelihood, magnitude, and frequency of exposure to the COPCs. The specific steps involved in the Exposure Assessment include the following:

Development of Exposure Scenarios

- Selection of present and future exposure scenarios
- Establishment of exposure parameters

Quantification of Exposure

- Estimation of exposure point concentrations
- Estimation of exposure doses

Exposure assumptions were developed based on demographics, land use, and general human behavior patterns. Exposure dose estimates were then calculated for each actual and potential exposure pathway and receptor population. Finally, the reasonable maximum exposure (RME) dose was calculated in accordance with *RAGS Part D* (USEPA 2001).

4.1 EXPOSURE PARAMETERS

The exposure parameters used for each exposure scenario are summarized in Tables 4.1 through 4.4 for each receptor population in the various media in each Attachment. The Reasonable Maximum Exposure (RME) hazard and risk were calculated first in the Risk Characterization, described below. For those receptors having unacceptable hazards and risks using RME assumptions, *RAGS Part D* recommends that the Central Tendency (CT) hazard and/or risk also be calculated in a second step. Where *RAGS Part D* was specific, those exposure parameters were adopted. If specific exposure parameters were not recommended in *RAGS Part D*, the *Exposure Factors Handbook* (USEPA 1997a), the *Standard Default Exposure Factors* guidance (USEPA 1991a*), Updated Dermal Exposure Assessment Guidance* (USEPA Region 3 2003) and *RAGS Part E* guidance (USEPA 2004) were consulted as additional resources to develop realistic exposure assumptions. Additionally, professional judgment was used to develop the exposure assumptions, especially for exposure frequency.

4.2 *QUANTIFICATION OF EXPOSURE DOSES*

The purpose of this section is to describe the methodology and approach for calculating COPC-specific chronic daily intakes (doses) for the receptors and pathways selected for quantitative evaluation in the HHRA.

The following standard USEPA equation (USEPA 1989) was used to estimate exposure doses received by the receptor populations for all scenarios:

$$I = \frac{C x CRate x AF x EF x ED}{BW x AT}$$

Where:

I	=	Chronic Daily Intake [dose] (mg/kg-day);
C	=	Concentration (mg/kg, mg/L or mg/m^3);
CRate	=	Contact rate (kg/day or L/day);
AF	=	Absorption factor (unitless);
EF	=	Exposure frequency (days/year);
ED	=	Exposure duration (years);
BW	=	Body weight (kg); and
AT	=	Averaging time (days).

Attachment A, Tables 4.1 and 4.2 provide the intake equations used to evaluate incidental ingestion of Red Clay Creek sediment (4.1), dermal contact with Red Clay Creek sediment (4.1) and inhalation of volatiles and/or particulates from Red Clay Creek sediment (4.3) for the current/future off-site adolescent trespasser. Tables 4.3 and 4.4 show the intake equations used to evaluate incidental ingestion of Red Clay Creek surface water (piezometer data) (4.3), dermal contact with Red Clay Creek surface water (piezometer data) (4.3) and inhalation of volatiles from Red Clay Creek surface water (piezometer data) (4.4) for the current/future off-site adolescent trespasser.

Attachment B, Tables 4.1 through 4.6 provide the intake equations used to evaluate incidental ingestion of Red Clay Creek sediment (4.1 adult, 4.3 child, 4.5 lifetime), dermal contact with Red Clay Creek sediment (4.1 adult, 4.3 child, 4.5 lifetime) and inhalation of volatiles and/or particulates from Red Clay Creek sediment (4.2 adult, 4.4 child, 4.6 lifetime) for the current/future off-site adult resident, child resident, lifetime resident, respectively. Tables 4.7 through 4.12 show the intake equations used to evaluate incidental ingestion of Red Clay Creek surface water (piezometer data) (4.7 adult, 4.9 child, 4.11 lifetime), dermal contact with Red Clay Creek surface water (piezometer data) (4.7 adult, 4.9 child, 4.11 lifetime) and inhalation of volatiles from Red Clay Creek surface water (piezometer data) (4.8 adult, 4.10 child, 4.12 lifetime) for the current/future off-site adult resident, child resident, lifetime resident, respectively.

Attachment C, Tables 4.1 through 4.6 provide the intake equations used to evaluate incidental ingestion of Red Clay Creek sediment (4.1 adult, 4.3 child, 4.5 lifetime), dermal contact with Red Clay Creek sediment (4.1 adult, 4.3 child, 4.5 lifetime) and inhalation of volatiles and/or particulates from Red Clay Creek sediment (4.2 adult, 4.4 child, 4.6 lifetime) for the future on-site adult resident, child resident, lifetime resident, respectively. Tables 4.7 through 4.12 show the intake equations used to evaluate incidental ingestion of Red Clay Creek surface water (piezometer data) (4.7 adult, 4.9 child, 4.11 lifetime), dermal contact with Red Clay Creek surface water (piezometer data) (4.7 adult, 4.9 child, 4.11 lifetime) and inhalation of volatiles from Red Clay Creek surface water (piezometer data) (4.8 adult, 4.10 child, 4.12 lifetime) for the future on-site adult resident, child resident, lifetime resident, respectively.

Attachment D, Tables 4.1 through 4.8 provide the intake equations used to evaluate ingestion of on-site ground water (4.1 adult, 4.3 child, 4.5 lifetime, 4.7 industrial worker), dermal contact with on-site ground water (4.1 adult, 4.3 child, 4.5 lifetime, 4.7 industrial worker) and inhalation of volatiles from on-site ground water while showering or bathing (4.2 adult, 4.4 child, 4.6 lifetime, 4.8 industrial worker) for the future on-site adult resident, child resident, lifetime resident, and industrial worker, respectively.

Attachment E, Tables 4.1 and 4.2 present the intake equations used to evaluate incidental ingestion of on-site ground water, dermal contact with on-site ground water and inhalation of volatiles from on-site ground water for the on-site construction worker.

Attachment F, Tables 4.1 and 4.2 present the intake equations used to evaluate incidental ingestion of on-site soils, dermal contact with on-site soils and inhalation of wind-blown particulates and vapors from on-site soils for the current on-site industrial worker.

Attachment G, Tables 4.1 and 4.2 present the intake equations used to evaluate incidental ingestion of on-site soils, dermal contact with on-site soils and inhalation of wind-blown particulates and vapors from on-site soils for the future on-site industrial worker.

Attachment H, Tables 4.1 and 4.2 present the intake equations used to evaluate incidental ingestion of on-site soils, dermal contact with on-site soils and inhalation of wind-blown particulates and vapors from on-site soils for the on-site construction worker.

Attachment I, Tables 4.1 through 4.6 present the intake equations used to evaluate incidental ingestion of on-site soils (4.1 adult, 4.3 child, 4.5 lifetime), dermal contact with on-site soils (4.1 adult, 4.3 child, 4.5 lifetime) and inhalation of wind-blown particulates and vapors from on-site soils (4.2 adult, 4.4 child, 4.6 lifetime) for the future on-site adult, child and lifetime resident, respectively.

5.0 TOXICITY ASSESSMENT AND CHEMICAL-SPECIFIC PARAMETERS

This section presents toxicity criteria and information that relates COPC exposure (dose) to anticipated health effects (response) for each COPC retained for quantitative evaluation in the HHRA. Toxicity criteria derived from dose-response data were used in the Risk Characterization section to estimate the non-carcinogenic hazards and carcinogenic risks associated with exposure to these COPCs.

Toxicity criteria used in this HHRA were obtained from USEPA's Integrated Risk Information System (IRIS) on-line database or other appropriate USEPA guidance documents when no toxicity criteria were available for the COPC in IRIS. Toxicity criteria were obtained from the following sources, listed in descending order of priority of use (USEPA 2001):

- IRIS (USEPA 2007);
- *Health Effects Assessment Summary Tables* (HEAST) (USEPA 1997b); USEPA's National Center for Environmental Assessment (NCEA) as indicated in USEPA Region 3's Risk-Based Concentration Tables dated 6 April 2007 (USEPA Region 3 2007); and
- USEPA's Provisional Peer-Reviewed Toxicity Values indicated on USEPA Region 3's Risk-Based Concentration Tables dated 6 April 2007 (USEPA Region 3 2007).

In each Attachment, Table 5.1 presents the available oral chronic reference doses (RfDs) used to evaluate non-carcinogenic hazards in the HHRA via the oral exposure route. Dermal RfDs were derived as shown on Table 5.1 to evaluate non-carcinogenic hazards via the dermal exposure route (see Section 5.1.2 for a description of deriving the dermal RfDs). As is shown on Table 5.2 in each Attachment, available inhalation reference concentrations were converted into inhalation reference doses in accordance with USEPA guidance (1989). Interim toxicity criteria obtained from NCEA and provisional peer-reviewed toxicity values, as presented in USEPA Region 3's Risk-Based Concentration Tables (2007), were also included in Tables 5.1 and 5.2 for certain RfDs which were not available in IRIS or HEAST. Table 5.3 shows that no special case chemicals were evaluated in the HHRA.

In each Attachment, Table 6.1 presents the available oral cancer slope factors (CSFs) used to evaluate carcinogenic risks in the HHRA via the oral exposure route. Dermal CSFs were derived as shown on Table 6.1 to evaluate carcinogenic risks via the dermal exposure route (see

Section 5.2.2 for a description of deriving the dermal CSFs). As is shown on Table 6.2 in each Attachment, available inhalation unit risk concentrations were converted into inhalation CSFs in accordance with USEPA guidance (USEPA 1989). Interim toxicity criteria obtained from NCEA and provisional peer-reviewed toxicity values, as presented in USEPA Region 3's Risk-Based Concentration Tables (2007), were also included in Tables 6.1 and 6.2 for certain CSFs which were not available in IRIS or HEAST. Table 6.3 shows that no special case chemicals were evaluated in the HHRA.

Dermal exposures were assessed using appropriate toxicity criteria and other exposure parameters (i.e., permeability coefficients) taken from USEPA guidance. Specific guidances used in conducting this HHRA included:

- *RAGS Part E* (USEPA 2004); and
- *Updated Dermal Exposure Assessment Guidance* (USEPA Region 3 2003).

5.1 REFERENCE DOSES

Non-carcinogenic adverse human health hazards were evaluated by analyzing long-term (chronic) exposures to COPCs. Chronic Reference Doses (RfDs) were used to evaluate long-term exposures. A chronic RfD is defined as an estimate (with uncertainty spanning perhaps an order of magnitude or greater) of a daily exposure concentration for the human population, including sensitive subpopulations, over a lifetime, that is likely to be without an adverse health effect.

Chronic RfDs are derived by USEPA using the following equation:

$$RfD\ (mg/kg-day) = \frac{NOAEL \quad or \quad LOAEL}{UF \quad x \quad MF}$$

where:

NOAEL = The "No Observable Adverse Effects Level," which represents a dose at which there is no statistically or biologically significant difference in frequency of an adverse effect between the exposed and control populations.

LOAEL = The "Lowest Observable Adverse Effects Level," which represents the lowest dose at which a statistically significant difference in the frequency of an adverse effect is observed.

UF = Uncertainty Factor; the UF is included to account for differences between species, variation in human sensitivity and extrapolations from the subchronic to the chronic NOAEL or from the LOAEL to the NOAEL.

MF = Modifying Factor; an additional uncertainty factor that accounts for uncertainties in the overall validity of the individual study and the database as a body of evidence.

5.1.1 Oral and Inhalation Pathways

The most current USEPA RfDs were used to evaluate the systemic effects of noncarcinogens. If the chronic oral RfD was unavailable for a given COPC and no appropriate surrogate criterion was available, oral exposure pathways were not assessed quantitatively in the HHRA (USEPA 2001). Likewise, if the chronic inhalation RfD was unavailable for a given COPC and no appropriate surrogate criterion was available, inhalation exposure pathways were not assessed quantitatively in the HHRA (USEPA 2001).

5.1.2 Dermal Pathway

USEPA has not developed RfDs specifically for the dermal pathway. As a surrogate for dermal RfDs, oral values were adjusted to account for absorption through the skin to allow comparison with calculated dermal doses which consider absorption (USEPA 1989, 2001, 2004; USEPA Region 3 2003). Specifically, oral RfDs were multiplied by *RAGS Part E* (USEPA 2004) recommended dermal absorption factors as shown on Table 5.1. These adjusted RfD values were used to evaluate dermal contact risks.

5.2 CANCER SLOPE FACTORS

5.2.1 Oral and Inhalation Pathways

The most current USEPA carcinogenicity criteria were used to evaluate the effects of known or suspected carcinogenic COPCs. The CSF is generally defined as the 95-percent upper confidence limit of the slope of the dose-response curve and is the result of the application of a low-dose extrapolation procedure. If slope factors for a given COPC were not available and no appropriate surrogate criteria were available, the applicable exposure pathways for that COPC were not assessed quantitatively (USEPA 2001).

5.2.2 *Dermal Pathway*

USEPA has not developed CSFs specifically for the dermal pathway. As a surrogate for dermal CSFs, oral values were adjusted to account for absorption through the skin to allow comparison with calculated dermal doses which consider absorption (USEPA 1989, 2001, 2004; USEPA Region 3 2003). Specifically, oral CSFs were divided by *RAGS Part E* (USEPA 2004a) recommended dermal absorption factors as shown on Table 6.1 in each Attachment. These adjusted oral toxicity values were used to evaluate cancer risks attributable to dermal contact exposure.

6.0 RISK CHARACTERIZATION

The goal of the Risk Characterization is to quantify the increased probability of developing cancer or experiencing an adverse acute, subchronic or chronic non-carcinogenic effect as a result of exposure to site constituents. The risk information is ultimately used in evaluating the necessity for remedial action at a site.

Potential current and future non-carcinogenic hazards and carcinogenic hazards attributable to the site COPCs are discussed in the Risk Characterization. The Risk Characterization integrates data developed from the Exposure Assessment and Toxicity Assessment to derive numerical estimates of non-carcinogenic hazards and carcinogenic risks. Hazard and risk attributable to site COPCs were assessed for each potential exposure medium (e.g., soil, sediment, surface water, air) under the "reasonable maximum exposure" (RME) conditions described previously, in accordance with *RAGS Part D* and USEPA Region 3 guidance. For those receptors having unacceptable hazards and risks using RME assumptions, *RAGS Part D* recommends that the Central Tendency (CT) hazard and/or risk also be calculated in a second step.

Hazard and risk are a function of constituent toxicity and the route and duration of exposure. USEPA's RfDs and CSFs were used as indicators of toxicity in the Risk Characterization. The COPC- and pathway-specific doses calculated in accordance with the methods outlined in the Exposure Assessment were used to represent exposure.

6.1 ESTIMATION OF NON-CARCINOGENIC HAZARD USING REASONABLE MAXIMUM EXPOSURE ASSUMPTIONS

Potential non-carcinogenic effects were evaluated based on a comparison of COPC-specific chronic exposure doses with corresponding protective doses derived from health criteria. The result of this comparison is expressed as the Hazard Quotient (HQ):

$$Hazard\ Quotient = \frac{Dose}{RfD}$$

A HQ that exceeds unity (1) suggests a greater likelihood of developing an adverse subchronic or chronic toxic effect. However, the uncertainty factors built into the protective doses result in conservative RfD values.

Therefore, the RfD is likely well below the level at which adverse effects may reasonably be anticipated to be observed.

HQs were calculated for each COPC for which health criteria are currently available. The HQs for each COPC were summed to produce a rough estimate of the pathway-specific risk, the Hazard Index (HI). In estimating total non-carcinogenic hazard, potential responses were conservatively assumed to be additive. However, all COPCs do not have the same or similar toxic endpoints and responses may not be additive.

The incremental non-carcinogenic hazard estimates for each receptor, each COPC and each exposure pathway are shown in each Attachment on the Tables 7.1.RME through 7.12.RME for the initial step of the Risk Characterization which evaluated RME exposures. Results for each receptor population are discussed in the following subsections.

6.1.1 *Current/Future Off-Site Adolescent Trespasser*

Attachment A, Tables 7.1 through 7.4 provide the HQs and HIs calculated for the current/future off-site adolescent trespasser in Red Clay Creek. HIs for incidental ingestion of sediment, dermal contact with sediment, inhalation of wind-blown particulates/vapors from sediment, incidental ingestion of surface water, dermal contact with surface water and inhalation of volatiles from surface water are shown in the table below for this receptor using RME exposure assumptions.

Current/Future Off-Site Adolescent Trespasser	Ingestion HQ (Table Ref.)	Dermal HQ (Table Ref.)	Inhalation HQ (Table Ref.)	HI
Sediment	3.8E-03 (AttA,7.1.RME)	9.0E-04 (AttA,7.1.RME)	0.0E+00 (AttA,7.2.RME)	4.7E-03
Surface Water (piezometer)	1.5E-01 (AttA,7.3.RME)	8.5E-01 (AttA,7.3.RME)	2.9E-02 (AttA,7.4.RME)	1.0E+00
HI Total Exposure				**1.0E+00**

The total HI across all exposure routes was estimated to be 1.0, equal to the target HI of unity (1). These results indicated that no adverse non-carcinogenic health effects would be expected to result from adolescent trespasser exposure to sediment and surface water (as represented by piezometer data) in Red Clay Creek adjacent to the site.

6.1.2 *Current/Future Off-Site Adult and Child Resident*

Attachment B, Tables 7.1 through 7.12 provide the HQs and HIs calculated for the current/future off-site adult and child residents in Red Clay Creek. HIs for incidental ingestion of sediment, dermal contact with sediment, inhalation of wind-blown particulates/vapors from sediment, incidental ingestion of surface water, dermal contact with surface water and inhalation of volatiles from surface water are shown in the table below for the adult resident using RME exposure assumptions.

Current/Future Off-Site Adult Resident	Ingestion HQ (Table Ref.)	Dermal HQ (Table Ref.)	Inhalation HQ (Table Ref.)	HI
Sediment	2.3E-04 (AttB,7.1.RME)	5.4E-05 (AttB,7.1.RME)	0.0E+00 (AttB,7.2.RME)	2.8E-04
Surface Water (piezometer)	1.2E-01 (AttB,7.7.RME)	3.2E-01 (AttB,7.7.RME)	6.1E-02 (AttB,7.8.RME)	5.1E-01
HI Total Exposure				**5.1E-01**

Total HI across all exposure routes for the current/future off-site adult resident was estimated to be 0.51, below the target HI of unity (1). These results indicated that no adverse non-carcinogenic health effects would be expected to result from adult resident exposure to sediment and surface water (as represented by piezometer data) in Red Clay Creek adjacent to the site.

HIs for incidental ingestion of sediment, dermal contact with sediment, inhalation of particulates from sediment, incidental ingestion of surface water, dermal contact with surface water and inhalation of volatiles from surface water are shown in the table below for the child resident using RME exposure assumptions.

Current/Future Off-Site Child Resident	Ingestion HQ (Table Ref.)	Dermal HQ (Table Ref.)	Inhalation HQ (Table Ref.)	HI
Sediment	2.1E-03 (AttB,7.3.RME)	3.5E-04 (AttB,7.3.RME)	0.0E+00 (AttB,7.4.RME)	2.4E-03
Surface Water (piezometer)	5.7E-01 (AttB,7.9.RME)	1.3E+00 (AttB,7.9.RME)	2.1E-01 (AttB,7.10.RME)	2.1E+00
HI Total Exposure				**2.1E+00**

The total HI across all exposure routes for the current/future off-site child resident was estimated to be 2.1, exceeding the target HI of unity (1). These results suggest an increased likelihood of adverse non-carcinogenic health effects associated with contact with surface water in Red Clay Creek (as represented by piezometer data). Ingestion of and dermal contact with VOCs and metals in piezometer data contributed the largest proportion of the total HI for the child resident.

Attachment B, Tables 7.5.RME, 7.6.RME, 7.11.RME and 7.12.RME show that non-carcinogenic hazard was not evaluated for the current/future off-site lifetime resident, as recommended by *RAGS Part D* (USEPA 2001).

6.1.3 Current On-Site Industrial Worker

In Attachments F1 through F7, Tables 7.1.RME and 7.2.RME provide the HQs and HIs calculated separately for each soil AOC/SWMU for the current on-site industrial worker. HIs for incidental ingestion of soil, dermal contact with soil, inhalation of wind-blown particulates/vapors from soil are shown in the table below for the current on-site industrial worker.

Current On-site Industrial Worker	Ingestion HQ (Table Ref.)	Dermal HQ (Table Ref.)	Inhalation HQ (Table Ref.)	HI
AOC-B Soil	1.7E-01 (AttF1,7.1.RME)	5.1E-02 (AttF1,7.1.RME)	0.0E+00 (AttF1,7.2.RME)	**2.2E-01**
AOC-E Soil	2.1E-01 (AttF2,7.1.RME)	2.0E-01 (AttF2,7.1.RME)	0.0E+00 (AttF2,7.2.RME)	**4.2E-01**
AOC-F Soil	1.0E-02 (AttF3,7.1.RME)	4.0E-03 (AttF3,7.1.RME)	0.0E+00 (AttF3,7.2.RME)	**1.4E-02**
SWMU-4 Soil	1.1E-02 (AttF4,7.1.RME)	3.7E-03 (AttF4,7.1.RME)	3.8E-02 (AttF4,7.2.RME)	**5.3E-02**
SWMU-7 Soil	0.0E+00 (AttF5,7.1.RME)	0.0E+00 (AttF5,7.1.RME)	0.0E+00 (AttF5,7.2.RME)	**0.0E+00**
SWMU-9D Soil	2.2E-01 (AttF6,7.1.RME)	5.2E-02 (AttF6,7.1.RME)	2.2E-05 (AttF6,7.2.RME)	**2.7E-01**
SWMU-12 Soil	2.1E-01 (AttF7,7.1.RME)	1.5E-01 (AttF7,7.1.RME)	3.6E-04 (AttF7,7.2.RME)	**3.7E-01**

Total HI across all exposure routes for the current on-site industrial worker at each of the soil AOC/SWMUs was estimated to be below the target HI of unity (1). These results indicated that adverse non-carcinogenic health effects would not be expected to result from adult on-site industrial worker exposure to soil on the site.

6.1.4 *Future On-Site Industrial Worker*

For the future on-site industrial worker exposure, non-carcinogenic hazards were calculated for each AOC/SWMU soil area and were added to the non-carcinogenic hazard calculated for hypothetical on-site industrial worker exposure to ground water. In Attachments G1 through G7, Tables 7.1.RME and 7.2.RME provide the HQs and HIs calculated separately for each soil AOC/SWMU for the future on-site industrial worker. Attachment D, Tables 7.6.RME and 7.7.RME provide the HQs and HIs calculated for the future on-site industrial worker exposure to ground water. HIs for incidental ingestion of soil, dermal contact with soil, inhalation of wind-blown particulates/vapors from soil, ingestion of ground water, dermal contact with ground water and inhalation of vapors from ground water, are shown in the table below for the future on-site industrial worker.

Future On-site Industrial Worker	Ingestion HQ (Table Ref.)	Dermal HQ (Table Ref.)	Inhalation HQ (Table Ref.)	HI
AOC-B Soil	1.7E-01 (AttG1,7.1.RME)	5.1E-02 (AttG1,7.1.RME)	0.0E+00 (AttG1,7.2.RME)	2.2E-01
Ground Water	1.9E+00 (AttD,7.6.RME)	5.0E-01 (AttD,7.6.RME)	2.5E+00 (AttD,7.7.RME)	4.9E+00
AOC B Total Exposure				**5.1E+00**
AOC-E Soil	2.1E-01 (AttG2,7.1.RME)	2.0E-01 (AttG2,7.1.RME)	0.0E+00 (AttG2,7.2.RME)	4.2E-01
Ground Water	1.9E+00 (AttD,7.6.RME)	5.0E-01 (AttD,7.6.RME)	2.5E+00 (AttD,7.7.RME)	4.9E+00
AOC E Total Exposure				**5.3E+00**
AOC-F Soil	1.0E-02	4.0E-03	0.0E+00	1.4E-02

	(AttG3,7.1.RME)	(AttG3,7.1.RME)	(AttG3,7.2.RME)	
Ground Water	1.9E+00 (AttD,7.6.RME)	5.0E-01 (AttD,7.6.RME)	2.5E+00 (AttD,7.7.RME)	4.9E+00
AOC F Total Exposure				**4.9E+00**
SWMU-4 Soil	1.1E-02 (AttG4,7.1.RME)	3.7E-03 (AttG4,7.1.RME)	3.8E-02 (AttG4,7.2.RME)	5.3E-02
Ground Water	1.9E+00 (AttD,7.6.RME)	5.0E-01 (AttD,7.6.RME)	2.5E+00 (AttD,7.7.RME)	4.9E+00
SWMU-4 Total Exposure				**5.0E+00**
SWMU-7 Soil	0.0E+00 (AttG5,7.1.RME)	0.0E+00 (AttG5,7.1.RME)	0.0E+00 (AttG5,7.2.RME)	0.0E+00
Ground Water	1.9E+00 (AttD,7.6.RME)	5.0E-01 (AttD,7.6.RME)	2.5E+00 (AttD,7.7.RME)	4.9E+00
SWMU-7 Total Exposure				**4.9E+00**
SWMU-9D Soil	2.2E-01 (AttG6,7.1.RME)	5.2E-02 (AttG6,7.1.RME)	2.2E-05 (AttG6,7.2.RME)	2.7E-01
Ground Water	1.9E+00 (AttD,7.6.RME)	5.0E-01 (AttD,7.6.RME)	2.5E+00 (AttD,7.7.RME)	4.9E+00
SWMU-9D Total Exposure				**5.2E+00**
SWMU-12 Soil	2.1E-01 (AttG7,7.1.RME)	1.5E-01 (AttG7,7.1.RME)	3.6E-04 (AttG7,7.2.RME)	3.7E-01
Ground Water	1.9E+00 (AttD,7.6.RME)	5.0E-01 (AttD,7.6.RME)	2.5E+00 (AttD,7.7.RME)	4.9E+00
SWMU-12 Total Exposure				**5.3E+00**

Total HIs across all exposure routes for the future on-site industrial worker exceeds the target HI of unity (1) at each AOC/SWMU. These results suggest an increased likelihood of adverse non-carcinogenic health effects associated with contact with on-site ground water. Ingestion of manganese and inhalation of benzene in ground water contributed the largest proportion of the total HI for the future on-site industrial worker.

6.1.5 *Current/Future On-Site Construction Worker*

For the current/future on-site construction worker exposure, non-carcinogenic hazards for calculated for each AOC/SWMU soil area were added to the non-carcinogenic hazard calculated for hypothetical on-site industrial worker exposure to ground water. In Attachments H1 through H7, Tables 7.1.RME and 7.2.RME provide the HQs and HIs calculated separately for each soil AOC/SWMU for the current/future on-site construction worker. Attachment E, Tables 7.1.RME and 7.2.RME provide the HQs and HIs calculated for the current/future on-site construction worker exposure to ground water. HIs for incidental ingestion of soil, dermal contact with soil, inhalation of wind-blown particulates/vapors from soil, ingestion of ground water, dermal contact with ground water and inhalation of vapors from ground water, are shown in the table below for the current/future on-site construction worker.

Current/Future On-site Construction Worker	Ingestion HQ (Table Ref.)	Dermal HQ (Table Ref.)	Inhalation HQ (Table Ref.)	HI
AOC-B Soil	3.3E-01 (AttH1,7.1.RME)	5.1E-02 (AttH1,7.1.RME)	0.0E+00 (AttH1,7.2.RME)	3.8E-01
Ground Water	6.8E-01 (AttE,7.1.RME)	1.5E+00 (AttE,7.1.RME)	5.0E-05 (AttE,7.2.RME)	2.2E+00
AOC B Total Exposure				**2.6E+00**
AOC-E Soil	4.3E-01 (AttH2,7.1.RME)	2.0E-01 (AttH2,7.1.RME)	0.0E+00 (AttH2,7.2.RME)	4.2E-01
Ground Water	6.8E-01 (AttE,7.1.RME)	1.5E+00 (AttE,7.1.RME)	5.0E-05 (AttE,7.2.RME)	2.2E+00
AOC E Total Exposure				**2.8E+00**
AOC-F Soil	2.0E-02 (AttH3,7.1.RME)	4.0E-03 (AttH3,7.1.RME)	0.0E+00 (AttH3,7.2.RME)	2.4E-02
Ground Water	6.8E-01 (AttE,7.1.RME)	1.5E+00 (AttE,7.1.RME)	5.0E-05 (AttE,7.2.RME)	2.2E+00
AOC F Total Exposure				**2.2E+00**
SWMU-4 Soil	2.2E-02 (AttH4,7.1.RME)	3.7E-03 (AttH4,7.1.RME)	3.6E-01 (AttH4,7.2.RME)	3.9E-01
Ground Water	6.8E-01 (AttE,7.1.RME)	1.5E+00 (AttE,7.1.RME)	5.0E-05 (AttE,7.2.RME)	2.2E+00
SWMU-4 Total Exposure				**2.6E+00**
SWMU-7 Soil	0.0E+00 (AttH5,7.1.RME)	0.0E+00 (AttH5,7.1.RME)	0.0E+00 (AttH5,7.2.RME)	0.0E+00
Ground Water	6.8E-01 (AttE,7.1.RME)	1.5E+00 (AttE,7.1.RME)	5.0E-05 (AttE,7.2.RME)	2.2E+00
SWMU-7 Total Exposure				**2.2E+00**
SWMU-9D Soil	2.2E-01 (AttH6,7.1.RME)	5.2E-02 (AttH6,7.1.RME)	2.2E-05 (AttH6,7.2.RME)	2.7E-01
Ground Water	6.8E-01 (AttE,7.1.RME)	1.5E+00 (AttE,7.1.RME)	5.0E-05 (AttE,7.2.RME)	2.2E+00
SWMU-9D Total Exposure				**2.5E+00**
SWMU-12 Soil	4.3E-01 (AttH7,7.1.RME)	1.5E-01 (AttH7,7.1.RME)	2.4E-03 (AttH7,7.2.RME)	5.8E-01
Ground Water	6.8E-01 (AttE,7.1.RME)	1.5E+00 (AttE,7.1.RME)	5.0E-05 (AttE,7.2.RME)	2.2E+00
SWMU-12 Total Exposure				**2.8E+00**

Total HIs across all exposure routes for the current/future on-site construction worker exceeds the target HI of unity (1) at each AOC/SWMU. These results indicate an increased likelihood of adverse non-carcinogenic health effects associated with contact with on-site groundwater. Dermal contact with manganese and vanadium in ground water contributed the largest proportion of the total HI for the current/future on-site construction worker.

6.1.6 *Hypothetical Future On-Site Resident*

For the hypothetical future on-site resident exposure, non-carcinogenic hazards were calculated for each AOC/SWMU soil area and were added to the non-carcinogenic hazard calculated for exposure to on-site ground water as well as sediment and surface water (represented by piezometer data) in Red Clay Creek. In Attachments I1 through I7, Tables 7.1.RME through 7.6.RME provide the HQs and HIs calculated separately for each soil AOC/SWMU for the hypothetical future on-site adult and child resident. Attachment D, Tables 7.1.RME through 7.3.RME provide the HQs and HIs calculated for the hypothetical future on-site adult and child resident exposure to ground water. Attachment C, Tables 7.1.RME through 7.12.RME provide HQs and HIs calculated for hypothetical future on-site resident exposure to sediment and surface water (represented by piezometer data) in Red Clay Creek.

HIs for incidental ingestion of soil, dermal contact with soil, inhalation of wind-blown particulates/vapors from soil, ingestion of ground water, dermal contact with ground water and inhalation of vapors from ground water, incidental ingestion of sediment, dermal contact with sediment, inhalation of wind-blown particulates/vapors from sediment, incidental ingestion of surface water, dermal contact with surface water and inhalation of volatiles from surface water are shown in the table below for the adult resident using RME exposure assumptions.

Future On-site Adult Resident	**Ingestion HQ (Table Ref.)**	**Dermal HQ (Table Ref.)**	**Inhalation HQ (Table Ref.)**	**HI**
AOC-B Soil	3.3E-01 (AttI1,7.1.RME)	5.1E-02 (AttI1,7.1.RME)	7.6E-04 (AttI1,7.2.RME)	3.8E-01
Ground Water	5.5E+00 (AttD,7.1.RME)	1.1E+00 (AttD,7.1.RME)	4.1E+00 (AttD,7.2.RME)	1.1E+01
Sediment	2.3E-04 (AttC,7.1.RME)	5.4E-05 (AttC,7.1.RME)	0.0E+00 (AttC,7.2.RME)	2.8E-04
Surface Water (piezometer)	1.2E-01 (AttC,7.7.RME)	3.2E-01 (AttC,7.7.RME)	6.1E-02 (AttC,7.8.RME)	5.1E-01
AOC B Total Exposure				**1.2E+01**
AOC-E Soil	4.6E-01 (AttI2,7.1.RME)	1.7E-01 (AttI2,7.1.RME)	9.3E-04 (AttI2,7.2.RME)	6.4E-01
Ground Water	5.5E+00 (AttD,7.1.RME)	1.1E+00 (AttD,7.1.RME)	4.1E+00 (AttD,7.2.RME)	1.1E+01
Sediment	2.3E-04 (AttC,7.1.RME)	5.4E-05 (AttC,7.1.RME)	0.0E+00 (AttC,7.2.RME)	2.8E-04
Surface Water (piezometer)	1.2E-01 (AttC,7.7.RME)	3.2E-01 (AttC,7.7.RME)	6.1E-02 (AttC,7.8.RME)	5.1E-01
AOC E Total Exposure				**1.2E+01**
AOC-F Soil	1.4E-01 (AttI3,7.1.RME)	2.5E-02 (AttI3,7.1.RME)	5.2E-04 (AttI3,7.2.RME)	1.7E-01
Ground Water	5.5E+00 (AttD,7.1.RME)	1.1E+00 (AttD,7.1.RME)	4.1E+00 (AttD,7.2.RME)	1.1E+01
Sediment	2.3E-04 (AttC,7.1.RME)	5.4E-05 (AttC,7.1.RME)	0.0E+00 (AttC,7.2.RME)	2.8E-04
Surface Water (piezometer)	1.2E-01 (AttC,7.7.RME)	3.2E-01 (AttC,7.7.RME)	6.1E-02 (AttC,7.8.RME)	5.1E-01
AOC F Total Exposure				**1.1E+01**
SWMU-4 Soil	1.9E-01 (AttI4,7.1.RME)	3.2E-03 (AttI4,7.1.RME)	5.7E-02 (AttI4,7.2.RME)	2.5E-01
Ground Water	5.5E+00 (AttD,7.1.RME)	1.1E+00 (AttD,7.1.RME)	4.1E+00 (AttD,7.2.RME)	1.1E+01
Sediment	2.3E-04 (AttC,7.1.RME)	5.4E-05 (AttC,7.1.RME)	0.0E+00 (AttC,7.2.RME)	2.8E-04
Surface Water (piezometer)	1.2E-01 (AttC,7.7.RME)	3.2E-01 (AttC,7.7.RME)	6.1E-02 (AttC,7.8.RME)	5.1E-01
SWMU-4 Total Exposure				**1.1E+01**
SWMU-7 Soil	0.0E+00 (AttI5,7.1.RME)	0.0E+00 (AttI5,7.1.RME)	0.0E+00 (AttI5,7.2.RME)	0.0E+00
Ground Water	5.5E+00 (AttD,7.1.RME)	1.1E+00 (AttD,7.1.RME)	4.1E+00 (AttD,7.2.RME)	1.1E+01
Sediment	2.3E-04	5.4E-05	0.0E+00	2.8E-04

	(AttC,7.1.RME)	(AttC,7.1.RME)	(AttC,7.2.RME)	
Surface Water (piezometer)	1.2E-01 (AttC,7.7.RME)	3.2E-01 (AttC,7.7.RME)	6.1E-02 (AttC,7.8.RME)	5.1E-01
SWMU-7 Total Exposure				**1.1E+01**
SWMU-9D Soil	3.5E-01 (AttI6,7.1.RME)	4.4E-02 (AttI6,7.1.RME)	8.0E-04 (AttI6,7.2.RME)	3.9E-01
Ground Water	5.5E+00 (AttD,7.1.RME)	1.1E+00 (AttD,7.1.RME)	4.1E+00 (AttD,7.2.RME)	1.1E+01
Sediment	2.3E-04 (AttC,7.1.RME)	5.4E-05 (AttC,7.1.RME)	0.0E+00 (AttC,7.2.RME)	2.8E-04
Surface Water (piezometer)	1.2E-01 (AttC,7.7.RME)	3.2E-01 (AttC,7.7.RME)	6.1E-02 (AttC,7.8.RME)	5.1E-01
SWMU-9D Total Exposure				**1.2E+01**
SWMU-12 Soil	3.5E-01 (AttI7,7.1.RME)	1.3E-01 (AttI7,7.1.RME)	7.0E-04 (AttI7,7.2.RME)	4.8E-01
Ground Water	5.5E+00 (AttD,7.1.RME)	1.1E+00 (AttD,7.1.RME)	4.1E+00 (AttD,7.2.RME)	1.1E+01
Sediment	2.3E-04 (AttC,7.1.RME)	5.4E-05 (AttC,7.1.RME)	0.0E+00 (AttC,7.2.RME)	2.8E-04
Surface Water (piezometer)	1.2E-01 (AttC,7.7.RME)	3.2E-01 (AttC,7.7.RME)	6.1E-02 (AttC,7.8.RME)	5.1E-01
SWMU-12 Total Exposure				**1.2E+01**

Total HIs across all exposure routes for the future on-site adult resident exceeds the target HI of unity (1) at each AOC/SWMU. These results indicate an increased likelihood of adverse non-carcinogenic health effects associated with contact with on-site groundwater. Ingestion of manganese and trichloroethene, and the inhalation of benzene and chlorobenzene in ground water contributed the largest proportion of the total HI for the future on-site adult resident.

HIs for incidental ingestion of soil, dermal contact with soil, inhalation of wind-blown particulates/vapors from soil, ingestion of ground water, dermal contact with ground water and inhalation of vapors from ground water, incidental ingestion of sediment, dermal contact with sediment, inhalation of wind-blown particulates/vapors from sediment, incidental ingestion of surface water, dermal contact with surface water and inhalation of volatiles from surface water are shown in the table below for the child resident using RME exposure assumptions.

Future On-site Child Resident	Ingestion HQ (Table Ref.)	Dermal HQ (Table Ref.)	Inhalation HQ (Table Ref.)	HI
AOC-B Soil	3.1E+00 (AttI1,7.3.RME)	3.4E-01 (AttI1,7.3.RME)	2.6E-03 (AttI1,7.4.RME)	3.4E+00
Ground Water	1.6E+01 (AttD,7.3.RME)	2.9E+00 (AttD,7.3.RME)	0.0E+00 (not evaluated)	1.9E+01
Sediment	2.1E-03 (AttB,7.3.RME)	3.5E-04 (AttB,7.3.RME)	0.0E+00 (AttB,7.4.RME)	2.4E-03
Surface Water (piezometer)	5.7E-01 (AttB,7.9.RME)	1.3E+00 (AttB,7.9.RME)	2.1E-01 (AttB,7.10.RME)	2.1E+00
AOC B Total Exposure				**2.5E+01**
AOC-E Soil	4.3E+00 (AttI2,7.3.RME)	1.1E+00 (AttI2,7.3.RME)	3.2E-03 (AttI2,7.4.RME)	5.4E+00
Ground Water	1.6E+01 (AttD,7.3.RME)	2.9E+00 (AttD,7.3.RME)	0.0E+00 (not evaluated)	1.9E+01
Sediment	2.1E-03 (AttB,7.3.RME)	3.5E-04 (AttB,7.3.RME)	0.0E+00 (AttB,7.4.RME)	2.4E-03
Surface Water (piezometer)	5.7E-01	1.3E+00	2.1E-01	2.1E+00

	(AttB,7.9.RME)	(AttB,7.9.RME)	(AttB,7.10.RME)	
AOC E Total Exposure				**2.7E+01**
AOC-F Soil	1.3E+00 (AttI3,7.3.RME)	1.6E-01 (AttI3,7.3.RME)	1.8E-03 (AttI3,7.4.RME)	1.5E+00
Ground Water	1.6E+01 (AttD,7.3.RME)	2.9E+00 (AttD,7.3.RME)	0.0E+00 (not evaluated)	1.9E+01
Sediment	2.1E-03 (AttB,7.3.RME)	3.5E-04 (AttB,7.3.RME)	0.0E+00 (AttB,7.4.RME)	2.4E-03
Surface Water (piezometer)	5.7E-01 (AttB,7.9.RME)	1.3E+00 (AttB,7.9.RME)	2.1E-01 (AttB,7.10.RME)	2.1E+00
AOC F Total Exposure				**2.3E+01**
SWMU-4 Soil	1.7E+00 (AttI4,7.3.RME)	2.1E-02 (AttI4,7.3.RME)	2.0E-01 (AttI4,7.4.RME)	2.0E+00
Ground Water	1.6E+01 (AttD,7.3.RME)	2.9E+00 (AttD,7.3.RME)	0.0E+00 (not evaluated)	1.9E+01
Sediment	2.1E-03 (AttB,7.3.RME)	3.5E-04 (AttB,7.3.RME)	0.0E+00 (AttB,7.4.RME)	2.4E-03
Surface Water (piezometer)	5.7E-01 (AttB,7.9.RME)	1.3E+00 (AttB,7.9.RME)	2.1E-01 (AttB,7.10.RME)	2.1E+00
SWMU-4 Total Exposure				**2.3E+01**
SWMU-7 Soil	0.0E+00 (AttI5,7.3.RME)	0.0E+00 (AttI5,7.3.RME)	0.0E+00 (AttI5,7.4.RME)	0.0E+00
Ground Water	1.6E+01 (AttD,7.3.RME)	2.9E+00 (AttD,7.3.RME)	0.0E+00 (not evaluated)	1.9E+01
Sediment	2.1E-03 (AttB,7.3.RME)	3.5E-04 (AttB,7.3.RME)	0.0E+00 (AttB,7.4.RME)	2.4E-03
Surface Water (piezometer)	5.7E-01 (AttB,7.9.RME)	1.3E+00 (AttB,7.9.RME)	2.1E-01 (AttB,7.10.RME)	2.1E+00
SWMU-7 Total Exposure				**2.1E+01**
SWMU-9D Soil	3.2E+00 (AttI6,7.3.RME)	2.8E-01 (AttI6,7.3.RME)	2.8E-03 (AttI6,7.4.RME)	3.5E+00
Ground Water	1.6E+01 (AttD,7.3.RME)	2.9E+00 (AttD,7.3.RME)	0.0E+00 (not evaluated)	1.9E+01
Sediment	2.1E-03 (AttB,7.3.RME)	3.5E-04 (AttB,7.3.RME)	0.0E+00 (AttB,7.4.RME)	2.4E-03
Surface Water (piezometer)	5.7E-01 (AttB,7.9.RME)	1.3E+00 (AttB,7.9.RME)	2.1E-01 (AttB,7.10.RME)	2.1E+00
SWMU-9D Total Exposure				**2.5E+01**
SWMU-12 Soil	3.2E+00 (AttI7,7.3.RME)	8.4E-01 (AttI7,7.3.RME)	2.4E-03 (AttI7,7.4.RME)	4.1E+00
Ground Water	1.6E+01 (AttD,7.3.RME)	2.9E+00 (AttD,7.3.RME)	0.0E+00 (not evaluated)	1.9E+01
Sediment	2.1E-03 (AttB,7.3.RME)	3.5E-04 (AttB,7.3.RME)	0.0E+00 (AttB,7.4.RME)	2.4E-03
Surface Water (piezometer)	5.7E-01 (AttB,7.9.RME)	1.3E+00 (AttB,7.9.RME)	2.1E-01 (AttB,7.10.RME)	2.1E+00
SWMU-12 Total Exposure				**2.5E+01**

Total HIs across all exposure routes for the future on-site child resident exceeds the target HI of unity (1) at each AOC/SWMU. These results indicate an increased likelihood of adverse non-carcinogenic health effects associated with contact with on-site soil, groundwater, and surface water in Red Clay Creek (represented by piezometer data). Ingestion of benzene, manganese and trichloroethene, and the dermal contact with manganese and vanadium in ground water contributed the largest proportion of the total HI for the future on-site child resident.

Non-carcinogenic hazard was not evaluated for the current/future on-site lifetime resident, as recommended by *RAGS Part D* (USEPA 2001).

6.2 ESTIMATION OF CARCINOGENIC RISK USING REASONABLE MAXIMUM EXPOSURE ASSUMPTIONS

The incremental carcinogenic risk associated with exposure to constituents detected at the site was calculated according to the following equation (USEPA 1989a):

$$Incremental\ Carcinogenic\ Risk = Cancer\ Slope\ Factor \times Dose$$

where the incremental carcinogenic risk represents the probability of developing cancer over a lifetime from exposure to the COPCs associated with the site. Cancer risk is unitless and is expressed here in scientific notation. For example, a risk of 1×10^{-6} indicates that an individual has one chance in one million of developing cancer as a result of exposure to site COPCs during a lifetime.

The cancer slope factor (CSF) represents the carcinogenic potency of a constituent. The dose, or intake, represents the amount of constituent to which a receptor is exposed. When evaluating carcinogenic risks, the dose is the estimated daily intake of each constituent during the specified period of exposure, and averaged over a lifetime.

USEPA has not established a specific value that represents a significant incremental cancer risk. However, USEPA's National Oil and Hazardous Substances Pollution Contingency Plan (NCP) acceptable risk range for Superfund sites has been set at approximately 1×10^{-6} to 1×10^{-4} per environmental medium (NCP, 1990). In other words, the goal of the NCP is to reduce the cancer risk associated with site COPCs in a given medium to within or below a range of one in one million to one in ten thousand.

Incremental carcinogenic risk was calculated for each COPC having a designated CSF for all applicable exposure pathways. Risk values for all COPCs assessed were summed by exposure pathway to provide total pathway-specific risks. The incremental carcinogenic risk estimates for each receptor, each COPC, and each exposure pathway are shown on Tables 8.1.RME through 8.12.RME for the initial step of the Risk Characterization which evaluated RME exposures. Results for each receptor population are discussed in the following subsections.

6.2.1 *Current/Future Off-Site Adolescent Trespasser*

Attachment A, Tables 8.1 through 8.4 provide the carcinogenic risks (CRs) calculated for the current/future off-site adolescent trespasser for Red Clay Creek. CRs for incidental ingestion of sediment, dermal contact with sediment, inhalation of wind-blown particulates/vapors from sediment, incidental ingestion of surface water, dermal contact with surface water and inhalation of volatiles from surface water are shown in the table below for this receptor using RME exposure assumptions.

Current/Future Off-Site Adolescent Trespasser	Ingestion CR (Table Ref.)	Dermal CR (Table Ref.)	Inhalation CR (Table Ref.)	Total CR
Sediment	1.5E-07 (AttA,8.1.RME)	3.5E-08 (AttA,8.1.RME)	7.6E-12 (AttA,8.2.RME)	1.8E-07
Surface Water (piezometer)	1.1E-06 (AttA,8.3.RME)	2.1E-05 (AttA,8.3.RME)	1.0E-06 (AttA,8.4.RME)	2.3E-05
CR Total Exposure				**2.3E-05**

The total CR across all exposure routes is within the NCP acceptable risk range of 1×10^{-6} to 1×10^{-4}. These results indicated that no significant increased cancer risk would be anticipated to result from adolescent trespasser exposure to sediment and surface water (as represented by piezometer data) in Red Clay Creek adjacent to the site.

6.2.2 *Current/Future Off-Site Adult and Child Resident*

Attachment B, Tables 8.1 through 8.12 provide the CRs calculated for the current/future off-site adult and child residents for Red Clay Creek. CRs for incidental ingestion of sediment, dermal contact with sediment, inhalation of wind-blown particulates/vapors from sediment, incidental ingestion of surface water, dermal contact with surface water and inhalation of volatiles from surface water are shown in the table below for the adult resident using RME exposure assumptions.

Current/Future Off-Site Adult Resident	Ingestion CR (Table Ref.)	Dermal CR (Table Ref.)	Inhalation CR (Table Ref.)	Total CR
Sediment	5.0E-07 (AttB,8.1.RME)	1.2E-07 (AttB,8.1.RME)	7.0E-11 (AttB,8.2.RME)	6.2E-07
Surface Water (piezometer)	3.3E-06 (AttB,8.7.RME)	3.5E-05 (AttB,8.7.RME)	9.2E-06 (AttB,8.8.RME)	4.7E-05
CR Total Exposure				**4.8E-05**

The total CR across all exposure routes is within the NCP acceptable risk range of 1×10^{-6} to 1×10^{-4}. These results indicated that no significant increased cancer risk would be anticipated to result from adult resident exposure to sediment and surface water (as represented by piezometer data) in Red Clay Creek adjacent to the site.

Attachment B, Tables 8.3.RME, 8.4.RME, 8.9.RME and 8.10.RME show that carcinogenic risk was not evaluated for the current/future off-site child resident, as recommended by *RAGS Part D* (USEPA 2001) (these risks are captured by the child/adult or lifetime resident exposure).

CRs for incidental ingestion of sediment, dermal contact with sediment, inhalation of particulates from sediment, incidental ingestion of surface water, dermal contact with surface water and inhalation of volatiles from surface water are shown in the table below for the lifetime resident using RME exposure assumptions.

Current/Future Off-Site Child /Adult Resident	Ingestion CR (Table Ref.)	Dermal CR (Table Ref.)	Inhalation CR (Table Ref.)	Total CR
Sediment	1.8E-06 (AttB,8.5.RME)	1.1E-06 (AttB,8.5.RME)	2.1E-10 (AttB,8.6.RME)	2.8E-06
Surface Water (piezometer)	1.2E-05 (AttB,8.11.RME)	1.0E-04 (AttB,8.11.RME)	2.7E-05 (AttB,8.12.RME)	1.4E-04
CR Total Exposure				**1.4E-04**

The total CR across all exposure routes for the current/future off-site child resident exceeds the NCP acceptable risk range of 1 x 10^{-6} to 1 x 10^{-4}. Ingestion of VOCs and dermal contact with indeno(1,2,3-cd)pyrene, DDD and TCE in piezometer data contributed the largest proportion of the total CR for the child resident.

6.2.3 *Current On-Site Industrial Worker*

In Attachments F1 through F7, Tables 8.1.RME and 8.2.RME provide the CRs calculated separately for each soil AOC/SWMU for the current on-site industrial worker. CRs for incidental ingestion of soil, dermal contact with soil, inhalation of wind-blown particulates/vapors from soil are shown in the table below for the current on-site industrial worker.

Current On-site Industrial Worker	Ingestion CR (Table Ref.)	Dermal CR (Table Ref.)	Inhalation CR (Table Ref.)	CR
AOC-B Soil	6.4E-06 (AttF1,8.1.RME)	4.5E-06 (AttF1,8.1.RME)	3.9E-10 (AttF1,8.2.RME)	**1.1E-05**
AOC-E Soil	1.3E-05 (AttF2,8.1.RME)	1.8E-05 (AttF2,8.1.RME)	3.0E-10 (AttF2,8.2.RME)	**3.1E-05**
AOC-F Soil	7.4E-06 (AttF3,8.1.RME)	4.5E-06 (AttF3,8.1.RME)	2.9E-10 (AttF3,8.2.RME)	**1.2E-05**
SWMU-4 Soil	2.5E-05 (AttF4,8.1.RME)	2.4E-05 (AttF4,8.1.RME)	3.1E-06 (AttF4,8.2.RME)	**5.2E-05**
SWMU-7 Soil	9.4E-05 (AttF5,8.1.RME)	3.7E-05 (AttF5,8.1.RME)	1.2E-09 (AttF5,8.2.RME)	**1.3E-04**
SWMU-9D Soil	1.2E-05 (AttF6,8.1.RME)	5.1E-06 (AttF6,8.1.RME)	1.1E-08 (AttF6,8.2.RME)	**1.7E-05**
SWMU-12 Soil	3.4E-05 (AttF7,8.1.RME)	2.7E-05 (AttF7,8.1.RME)	1.2E-9 (AttF7,8.2.RME)	**6.0E-05**

Total CRs across all exposure routes for the current on-site industrial worker at each of the soil AOC/SWMUs, except SWMU-7, were estimated to be within the NCP acceptable risk range of 1 x 10^{-6} to 1 x 10^{-4}. Ingestion of total TCDD TEC contributed the largest proportion of the total CR to the adult on-site industrial worker exposure to soil at SWMU-7.

6.2.4 *Future On-Site Industrial Worker*

For the future on-site industrial worker exposure, CRs calculated for each AOC/SWMU soil area were added to the CRs calculated for hypothetical on-site industrial worker exposure to ground water. In Attachments G1 through G7, Tables 8.1.RME and 8.2.RME provide the CRs calculated separately for each soil AOC/SWMU for the future on-site industrial worker. Attachment D, Tables 8.6.RME and 8.7.RME provide the CRs calculated for the future on-site industrial worker exposure to ground water. CRs for incidental ingestion of soil, dermal contact with soil, inhalation of wind-blown particulates/vapors from soil, ingestion of ground water, dermal contact with ground water and inhalation of vapors from ground water, are shown in the table below for the future on-site industrial worker.

Future On-site Industrial Worker	Ingestion CR (Table Ref.)	Dermal CR (Table Ref.)	Inhalation CR (Table Ref.)	CR
AOC-B Soil	6.4E-06 (AttG1,8.1.RME)	4.5E-06 (AttG1,8.1.RME)	3.9E-10 (AttG1,8.2.RME)	1.1E-05
Ground Water	1.2E-04 (AttD,8.6.RME)	8.2E-05 (AttD,8.6.RME)	4.0E-04 (AttD,8.7.RME)	6.0E-04
AOC B Total Exposure				**6.1E-04**
AOC-E Soil	1.3E-05 (AttG2,8.1.RME)	1.8E-05 (AttG2,8.1.RME)	3.0E-10 (AttG2,8.2.RME)	3.1E-05
Ground Water	1.2E-04 (AttD,8.6.RME)	8.2E-05 (AttD,8.6.RME)	4.0E-04 (AttD,8.7.RME)	6.0E-04
AOC E Total Exposure				**6.3E-04**
AOC-F Soil	7.4E-06 (AttG3,8.1.RME)	4.5E-06 (AttG3,8.1.RME)	2.9E-10 (AttG3,8.2.RME)	1.2E-05
Ground Water	1.2E-04 (AttD,8.6.RME)	8.2E-05 (AttD,8.6.RME)	4.0E-04 (AttD,8.7.RME)	6.0E-04
AOC F Total Exposure				**6.1E-04**
SWMU-4 Soil	2.5E-05 (AttG4,8.1.RME)	2.4E-05 (AttG4,8.1.RME)	3.1E-06 (AttG4,8.2.RME)	5.2E-05
Ground Water	1.2E-04 (AttD,8.6.RME)	8.2E-05 (AttD,8.6.RME)	4.0E-04 (AttD,8.7.RME)	6.0E-04
SWMU-4 Total Exposure				**6.5E-04**
SWMU-7 Soil	9.4E-05 (AttG5,8.1.RME)	3.7E-05 (AttG5,8.1.RME)	1.2E-09 (AttG5,8.2.RME)	1.3E-04
Ground Water	1.2E-04 (AttD,8.6.RME)	8.2E-05 (AttD,8.6.RME)	4.0E-04 (AttD,8.7.RME)	6.0E-04
SWMU-7 Total Exposure				**7.3E-04**
SWMU-9D Soil	1.2E-05 (AttG6,8.1.RME)	5.1E-06 (AttG6,8.1.RME)	1.1E-08 (AttG6,8.2.RME)	1.7E-05
Ground Water	1.2E-04 (AttD,8.6.RME)	8.2E-05 (AttD,8.6.RME)	4.0E-04 (AttD,8.7.RME)	6.0E-04
SWMU-9D Total Exposure				**6.2E-04**
SWMU-12 Soil	4.0E-05 (AttG7,8.1.RME)	2.7E-05 (AttG7,8.1.RME)	1.2E-9 (AttG7,8.2.RME)	6.6E-05
Ground Water	1.2E-04 (AttD,8.6.RME)	8.2E-05 (AttD,8.6.RME)	4.0E-04 (AttD,8.7.RME)	6.0E-04
SWMU-12 Total Exposure				**6.6E-04**

Total CRs across all exposure routes for the future on-site industrial worker exceeds the NCP acceptable risk range of 1 x 10^{-6} to 1 x 10^{-4} at each AOC/SWMU. Ingestion and inhalation of VOCs in ground water contributed the largest proportion of the total CR for the future on-site industrial worker.

6.2.5 *Current/Future On-Site Construction Worker*

For the current/future on-site construction worker exposure, CRs were calculated for each AOC/SWMU soil area were added to the CRs calculated for current/future on-site construction worker exposure to ground water. In Attachments H1 through H7, Tables 8.1.RME and 8.2.RME provide the CRs calculated separately for each soil AOC/SWMU for the current/future on-site construction worker. Attachment E, Tables 8.1.RME and 8.2.RME provide the CRs calculated for the current/future on-site construction worker exposure to ground water. CRs for incidental ingestion of soil, dermal contact with soil, inhalation of wind-blown particulates/vapors from soil, ingestion of ground water, dermal contact with ground water and inhalation of vapors from ground water, are shown in the table below for the current/future on-site construction worker.

Current/Future On-site Construction Worker	**Ingestion CR (Table Ref.)**	**Dermal CR (Table Ref.)**	**Inhalation CR (Table Ref.)**	**CR**
AOC-B Soil	5.1E-07 (AttH1,8.1.RME)	1.8E-07 (AttH1,8.1.RME)	1.0E-10 (AttH1,8.2.RME)	6.9E-07
Ground Water	1.7E-06 (AttE,8.1.RME)	3.2E-06 (AttE,8.1.RME)	4.0E-10 (AttE,8.2.RME)	4.9E-06
AOC B Total Exposure				**5.6E-06**
AOC-E Soil	1.1E-06 (AttH2,8.1.RME)	7.2E-07 (AttH2,8.1.RME)	7.9E-11 (AttH2,8.2.RME)	1.8E-06
Ground Water	1.7E-06 (AttE,8.1.RME)	3.2E-06 (AttE,8.1.RME)	4.0E-10 (AttE,8.2.RME)	4.9E-06
AOC E Total Exposure				**6.7E-06**
AOC-F Soil	5.9E-07 (AttH3,8.1.RME)	1.8E-07 (AttH3,8.1.RME)	7.6E-11 (AttH3,8.2.RME)	7.7E-07
Ground Water	1.7E-06 (AttE,8.1.RME)	3.2E-06 (AttE,8.1.RME)	4.0E-10 (AttE,8.2.RME)	4.9E-06
AOC F Total Exposure				**5.6E-06**
SWMU-4 Soil	2.0E-06 (AttH4,8.1.RME)	9.5E-07 (AttH4,8.1.RME)	1.2E-06 (AttH4,8.2.RME)	4.2E-06
Ground Water	1.7E-06 (AttE,8.1.RME)	3.2E-06 (AttE,8.1.RME)	4.0E-10 (AttE,8.2.RME)	4.9E-06
SWMU-4 Total Exposure				**9.0E-06**
SWMU-7 Soil	7.5E-06 (AttH5,8.1.RME)	1.5E-06 (AttH5,8.1.RME)	3.3E-10 (AttH5,8.2.RME)	9.0E-06
Ground Water	1.7E-06 (AttE,8.1.RME)	3.2E-06 (AttE,8.1.RME)	4.0E-10 (AttE,8.2.RME)	4.9E-06
SWMU-7 Total Exposure				**1.4E-05**
SWMU-9D Soil	9.7E-07 (AttH6,8.1.RME)	2.0E-07 (AttH6,8.1.RME)	2.9E-09 (AttH6,8.2.RME)	1.2E-06
Ground Water	1.7E-06 (AttE,8.1.RME)	3.2E-06 (AttE,8.1.RME)	4.0E-10 (AttE,8.2.RME)	4.9E-06
SWMU-9D Total Exposure				**6.0E-06**
SWMU-12 Soil	3.2E-06 (AttH7,8.1.RME)	1.1E-06 (AttH7,8.1.RME)	3.2E-10 (AttH7,8.2.RME)	4.2E-06
Ground Water	1.7E-06 (AttE,8.1.RME)	3.2E-06 (AttE,8.1.RME)	4.0E-10 (AttE,8.2.RME)	4.9E-06
SWMU-12 Total Exposure				**9.1E-06**

Total CRs across all exposure routes for the current/future on-site construction worker were estimated to be within the NCP acceptable risk range of 1×10^{-6} to 1×10^{-4} at each AOC/SWMU.

6.2.6 *Future On-Site Resident*

For the hypothetical future on-site resident exposure, CRs for calculated for each AOC/SWMU soil area were added to the CRs calculated for exposure to on-site ground water as well as sediment and surface water (represented by piezometer data) in Red Clay Creek. In Attachments I1 through I7, Tables 8.1.RME through 8.6.RME provide the CRs calculated separately for each soil AOC/SWMU for the hypothetical future on-site adult and child resident. Attachment D, Tables 8.1.RME through 8.3.RME provide the CRs calculated for the hypothetical future on-site adult and child resident exposure to ground water. Attachment C, Tables 8.1.RME through 8.12.RME provide CRs calculated for hypothetical future on-site resident exposure to sediment and surface water (represented by piezometer data) in Red Clay Creek.

CRs for incidental ingestion of soil, dermal contact with soil, inhalation of wind-blown particulates/vapors from soil, ingestion of ground water, dermal contact with ground water and inhalation of vapors from ground water, incidental ingestion of sediment, dermal contact with sediment, inhalation of wind-blown particulates/vapors from sediment, incidental ingestion of surface water, dermal contact with surface water and inhalation of volatiles from surface water are shown in the table below for the adult resident using RME exposure assumptions.

Future On-site Adult Resident	Ingestion CR (Table Ref.)	Dermal CR (Table Ref.)	Inhalation CR (Table Ref.)	CR
AOC-B Soil	1.1E-05 (AttI1,8.1.RME)	5.3E-06 (AttI1,8.1.RME)	1.0E-08 (AttI1,8.2.RME)	1.7E-05
Ground Water	4.1E-04 (AttD,8.1.RME)	1.7E-04 (AttD,8.1.RME)	7.9E-04 (AttD,8.2.RME)	1.4E-03
Sediment	5.0E-07 (AttB,8.1.RME)	1.2E-07 (AttB,8.1.RME)	7.0E-11 (AttB,8.2.RME)	6.2E-07
Surface Water (piezometer)	3.3E-06 (AttB,8.7.RME)	3.5E-05 (AttB,8.7.RME)	9.2E-06 (AttB,8.8.RME)	4.7E-05
AOC B Total Exposure				**1.4E-03**
AOC-E Soil	1.9E-05 (AttI2,8.1.RME)	1.6E-05 (AttI2,8.1.RME)	4.5E-10 (AttI2,8.2.RME)	3.5E-05
Ground Water	4.1E-04 (AttD,8.1.RME)	1.7E-04 (AttD,8.1.RME)	7.9E-04 (AttD,8.2.RME)	1.4E-03
Sediment	5.0E-07 (AttB,8.1.RME)	1.2E-07 (AttB,8.1.RME)	7.0E-11 (AttB,8.2.RME)	6.2E-07
Surface Water (piezometer)	3.3E-06 (AttB,8.7.RME)	3.5E-05 (AttB,8.7.RME)	9.2E-06 (AttB,8.8.RME)	4.7E-05
AOC E Total Exposure				**1.4E-03**
AOC-F Soil	1.2E-05 (AttI3,8.1.RME)	5.4E-06 (AttI3,8.1.RME)	6.6E-09 (AttI3,8.2.RME)	1.8E-05
Ground Water	4.1E-04 (AttD,8.1.RME)	1.7E-04 (AttD,8.1.RME)	7.9E-04 (AttD,8.2.RME)	1.4E-03
Sediment	5.0E-07 (AttB,8.1.RME)	1.2E-07 (AttB,8.1.RME)	7.0E-11 (AttB,8.2.RME)	6.2E-07
Surface Water (piezometer)	3.3E-06 (AttB,8.7.RME)	3.5E-05 (AttB,8.7.RME)	9.2E-06 (AttB,8.8.RME)	4.7E-05
AOC F Total Exposure				**1.4E-03**
SWMU-4 Soil	3.7E-05 (AttI4,8.1.RME)	2.1E-05 (AttI4,8.1.RME)	4.9E-06 (AttI4,8.2.RME)	6.3E-05
Ground Water	4.1E-04	1.7E-04	7.9E-04	1.4E-03

	(AttD,8.1.RME)	(AttD,8.1.RME)	(AttD,8.2.RME)	
Sediment	5.0E-07 (AttB,8.1.RME)	1.2E-07 (AttB,8.1.RME)	7.0E-11 (AttB,8.2.RME)	6.2E-07
Surface Water (piezometer)	3.3E-06 (AttB,8.7.RME)	3.5E-05 (AttB,8.7.RME)	9.2E-06 (AttB,8.8.RME)	4.7E-05
SWMU-4 Total Exposure				**1.5E-03**
SWMU-7 Soil	1.4E-04 (AttI5,8.1.RME)	3.3E-05 (AttI5,8.1.RME)	1.9E-09 (AttI5,8.2.RME)	1.7E-04
Ground Water	4.1E-04 (AttD,8.1.RME)	1.7E-04 (AttD,8.1.RME)	7.9E-04 (AttD,8.2.RME)	1.4E-03
Sediment	5.0E-07 (AttB,8.1.RME)	1.2E-07 (AttB,8.1.RME)	7.0E-11 (AttB,8.2.RME)	6.2E-07
Surface Water (piezometer)	3.3E-06 (AttB,8.7.RME)	3.5E-05 (AttB,8.7.RME)	9.2E-06 (AttB,8.8.RME)	4.7E-05
SWMU-7 Total Exposure				**1.6E-03**
SWMU-9D Soil	1.9E-05 (AttI6,8.1.RME)	5.4E-06 (AttI6,8.1.RME)	1.7E-08 (AttI6,8.2.RME)	2.4E-05
Ground Water	4.1E-04 (AttD,8.1.RME)	1.7E-04 (AttD,8.1.RME)	7.9E-04 (AttD,8.2.RME)	1.4E-03
Sediment	5.0E-07 (AttB,8.1.RME)	1.2E-07 (AttB,8.1.RME)	7.0E-11 (AttB,8.2.RME)	6.2E-07
Surface Water (piezometer)	3.3E-06 (AttB,8.7.RME)	3.5E-05 (AttB,8.7.RME)	9.2E-06 (AttB,8.8.RME)	4.7E-05
SWMU-9D Total Exposure				**1.4E-03**
SWMU-12 Soil	5.9E-05 (AttI7,8.1.RME)	2.5E-05 (AttI7,8.1.RME)	7.7E-09 (AttI7,8.2.RME)	8.4E-05
Ground Water	4.1E-04 (AttD,8.1.RME)	1.7E-04 (AttD,8.1.RME)	7.9E-04 (AttD,8.2.RME)	1.4E-03
Sediment	5.0E-07 (AttB,8.1.RME)	1.2E-07 (AttB,8.1.RME)	7.0E-11 (AttB,8.2.RME)	6.2E-07
Surface Water (piezometer)	3.3E-06 (AttB,8.7.RME)	3.5E-05 (AttB,8.7.RME)	9.2E-06 (AttB,8.8.RME)	4.7E-05
SWMU-12 Total Exposure				**1.5E-03**

Total CRs across all exposure routes for the future on-site adult resident exceeds the NCP acceptable risk range of 1 x 10^{-6} to 1 x 10^{-4} at each AOC/SWMU. Ingestion of arsenic and VOCs in ground water, and the inhalation and dermal contact with VOCs in ground water contributed the largest proportion of the total CR for the future on-site adult resident.

Carcinogenic risk was not evaluated for the future on-site child resident, as recommended by *RAGS Part D* (USEPA 2001) (these risks are captured by the child/adult, or lifetime, resident exposure).

CRs for incidental ingestion of soil, dermal contact with soil, inhalation of wind-blown particulates/vapors from soil, ingestion of ground water, dermal contact with ground water and inhalation of vapors from ground water, incidental ingestion of sediment, dermal contact with sediment, inhalation of wind-blown particulates/vapors from sediment, incidental ingestion of surface water, dermal contact with surface water and inhalation of volatiles from surface water are shown in the table below for the lifetime resident using RME exposure assumptions.

Future On-site Child/Adult Resident	**Ingestion CR (Table Ref.)**	**Dermal CR (Table Ref.)**	**Inhalation CR (Table Ref.)**	**CR**
AOC-B Soil	4.0E-05 (AttI1,8.5.RME)	1.6E-05 (AttI1,8.5.RME)	3.0E-08 (AttI1,8.6.RME)	5.6E-05

Ground Water	1.2E-03 (AttD,8.4.RME)	5.3E-04 (AttD,8.4.RME)	2.1E-03 (AttD,8.5.RME)	3.9E-03
Sediment	1.8E-06 (AttB,8.5.RME)	1.1E-06 (AttB,8.5.RME)	2.1E-10 (AttB,8.6.RME)	2.8E-06
Surface Water (piezometer)	1.2E-05 (AttB,8.11.RME)	1.0E-04 (AttB,8.11.RME)	2.7E-05 (AttB,8.12.RME)	1.4E-04
AOC B Total Exposure				**4.1E-03**
AOC-E Soil	6.9E-05 (AttI2,8.5.RME)	4.9E-05 (AttI2,8.5.RME)	1.3E-09 (AttI2,8.6.RME)	1.2E-04
Ground Water	1.2E-03 (AttD,8.4.RME)	5.3E-04 (AttD,8.4.RME)	2.1E-03 (AttD,8.5.RME)	3.9E-03
Sediment	1.8E-06 (AttB,8.5.RME)	1.1E-06 (AttB,8.5.RME)	2.1E-10 (AttB,8.6.RME)	2.8E-06
Surface Water (piezometer)	1.2E-05 (AttB,8.11.RME)	1.0E-04 (AttB,8.11.RME)	2.7E-05 (AttB,8.12.RME)	1.4E-04
AOC E Total Exposure				**4.3E-03**
AOC-F Soil	4.4E-05 (AttI3,8.5.RME)	1.6E-05 (AttI3,8.5.RME)	2.0E-08 (AttI3,8.6.RME)	6.0E-05
Ground Water	1.2E-03 (AttD,8.4.RME)	5.3E-04 (AttD,8.4.RME)	2.1E-03 (AttD,8.5.RME)	3.9E-03
Sediment	1.8E-06 (AttB,8.5.RME)	1.1E-06 (AttB,8.5.RME)	2.1E-10 (AttB,8.6.RME)	2.8E-06
Surface Water (piezometer)	1.2E-05 (AttB,8.11.RME)	1.0E-04 (AttB,8.11.RME)	2.7E-05 (AttB,8.12.RME)	1.4E-04
AOC F Total Exposure				**4.1E-03**
SWMU-4 Soil	1.3E-04 (AttI4,8.5.RME)	6.5E-05 (AttI4,8.5.RME)	1.4E-05 (AttI4,8.6.RME)	2.1E-04
Ground Water	1.2E-03 (AttD,8.4.RME)	5.3E-04 (AttD,8.4.RME)	2.1E-03 (AttD,8.5.RME)	3.9E-03
Sediment	1.8E-06 (AttB,8.5.RME)	1.1E-06 (AttB,8.5.RME)	2.1E-10 (AttB,8.6.RME)	2.8E-06
Surface Water (piezometer)	1.2E-05 (AttB,8.11.RME)	1.0E-04 (AttB,8.11.RME)	2.7E-05 (AttB,8.12.RME)	1.4E-04
SWMU-4 Total Exposure				**4.2E-03**
SWMU-7 Soil	4.9E-04 (AttI5,8.5.RME)	1.0E-04 (AttI5,8.5.RME)	5.6E-09 (AttI5,8.6.RME)	5.9E-04
Ground Water	1.2E-03 (AttD,8.4.RME)	5.3E-04 (AttD,8.4.RME)	2.1E-03 (AttD,8.5.RME)	3.9E-03
Sediment	1.8E-06 (AttB,8.5.RME)	1.1E-06 (AttB,8.5.RME)	2.1E-10 (AttB,8.6.RME)	2.8E-06
Surface Water (piezometer)	1.2E-05 (AttB,8.11.RME)	1.0E-04 (AttB,8.11.RME)	2.7E-05 (AttB,8.12.RME)	1.4E-04
SWMU-7 Total Exposure				**4.6E-03**
SWMU-9D Soil	6.6E-05 (AttI6,8.5.RME)	1.6E-05 (AttI6,8.5.RME)	4.9E-08 (AttI6,8.6.RME)	8.3E-05
Ground Water	1.2E-03 (AttD,8.4.RME)	5.3E-04 (AttD,8.4.RME)	2.1E-03 (AttD,8.5.RME)	3.9E-03
Sediment	1.8E-06 (AttB,8.5.RME)	1.1E-06 (AttB,8.5.RME)	2.1E-10 (AttB,8.6.RME)	2.8E-06
Surface Water (piezometer)	1.2E-05 (AttB,8.11.RME)	1.0E-04 (AttB,8.11.RME)	2.7E-05 (AttB,8.12.RME)	1.4E-04
SWMU-9D Total Exposure				**4.1E-03**
SWMU-12 Soil	2.1E-04 (AttI7,8.5.RME)	7.6E-05 (AttI7,8.5.RME)	2.3E-08 (AttI7,8.6.RME)	2.9E-04
Ground Water	1.2E-03 (AttD,8.4.RME)	5.3E-04 (AttD,8.4.RME)	2.1E-03 (AttD,8.5.RME)	3.9E-03
Sediment	1.8E-06 (AttB,8.5.RME)	1.1E-06 (AttB,8.5.RME)	2.1E-10 (AttB,8.6.RME)	2.8E-06
Surface Water (piezometer)	1.2E-05 (AttB,8.11.RME)	1.0E-04 (AttB,8.11.RME)	2.7E-05 (AttB,8.12.RME)	1.4E-04
SWMU-12 Total Exposure				**4.3E-03**

Total CRs across all exposure routes for the future on-site lifetime resident exceeds the NCP acceptable risk range of 1 x 10^{-6} to 1 x 10^{-4} at each AOC/SWMU. Ingestion of arsenic and VOCs in ground water, inhalation and dermal contact with VOCs in ground water, ingestion of VOCs and dermal contact with indeno(1,2,3-cd)pyrene, DDD, and TCE in the piezometer data contributed the largest proportion of the total CR for the lifetime resident.

6.3 *SUMMARY OF NON-CARCINOGENIC HAZARD AND CARCINOGENIC RISK USING REASONABLE MAXIMUM EXPOSURE ASSUMPTIONS*

Tables 9.RME through 9.3.RME in each Attachment summarize the non-carcinogenic hazards and carcinogenic risk estimated for the six receptor populations evaluated in the HHRA using RME exposure assumptions, as shown in detail on Tables 7.1.RME through 7.12.RME and Tables 8.1.RME through 8.12.RME, respectively. In those cases where the total HI across all media and all exposure routes exceeded unity (1) for a receptor, *RAGS Part D* (USEPA 2001) requires that primary target organ-specific HIs be calculated for that receptor. The primary target organs shown in Tables 9.RME through 9.3.RME (in each Attachment) were the target organs on which the RfDs were based, as detailed in the specific USEPA toxicity criteria documents referenced in Tables 5.1 and 5.2. COPCs affecting the whole body and COPCs for which the RfD was based on a NOEL or NOAEL were conservatively added to each specific target organ HI.

Attachment A, Table 9.RME provides the summary of hazards and risks for the current/future off-site adolescent trespasser. As was stated in Section 6.1.1, the total HI across all media and exposure routes was 1.0E+00. As was stated in Section 6.2.1, the total CR across all media and exposure routes was 2.3E-05.

Attachment B, Tables 9.1.RME, 9.2.RME and 9.3.RME provide the summary of hazards and risks for the current/future off-site adult resident, child resident, lifetime resident, respectively. As was stated in Section 6.1.2, the total HI across all media and exposure routes was 5.1E-01 and 2.1E+00 for the adult resident and child resident, respectively. For the child resident, the total skin HI was 0.3, the total liver HI was 0.83, the total blood HI was 0.34, the total GI tract HI was 0.3, the total nasal cavity HI was 0.48 and the total CNS HI was 1.3. As was stated in Section 6.2.2, the total CR across all media and exposure routes was 4.8E-05 and 1.4E-04 for the adult resident and lifetime resident, respectively.

In Attachments F1 through F7, Table 9.RME provides the summary of hazards and risks for the current on-site industrial worker at AOC-B, AOC-E, AOC-F, SWMU-4, SWMU-7, SWMU-9D and SWMU-12, respectively. As was stated in Section 6.1.3, the total HI across all media and exposure routes at each of these AOC/SWMUs was 2.2E-01, 4.2E-01, 1.4E-02, 5.3E-02, 0.0E+00, 2.7E-01 and 3.7E-01, respectively. As was stated in Section 6.2.3, the total CR across all media and exposure routes was 1.1E-05, 3.1E-05, 1.2E-05, 5.2E-05, 1.3E-04, 1.7E-05 and 6.0E-05, respectively.

In Attachments G1 through G7, Table 9.RME provides the summary of hazards and risks for the future on-site industrial worker at AOC-B, AOC-E, AOC-F, SWMU-4, SWMU-7, SWMU-9D and SWMU-12, respectively. As was stated in Section 6.1.4, the total HI across all media and exposure routes at each of these AOC/SWMUs was 5.1E+00, 5.3E+00, 4.9E+00, 5.0E+00, 4.9E+00, 5.2E+00 and 5.3E+00, respectively. Target organ HIs for the future on-site industrial worker at each SWMU/AOC are presented below:

Target Organ	AOC-B	AOC-E	AOC-F	SWMU-4	SWMU-7	SWMU-9D	SWMU-12
Skin	0.38	0.37	0.27	0.28	0.27	0.46	0.4
Kidney	- -	- -	- -	- -	- -	0.35	- -
Brain	0.27	0.28	0.18	0.18	0.18	0.3	0.26
CNS	1.4	1.4	1.3	1.3	1.3	1.5	1.4
Liver	1.1	1.1	0.98	0.98	0.98	1.1	1.0
Immune Func.	2.5	2.8	2.4	2.4	2.4	2.6	2.7
Blood	0.33	0.33	0.23	0.23	0.23	0.35	0.32
Nasal Cavity	0.68	0.69	0.59	0.59	0.59	0.71	0.67
Lung	- -	- -	- -	- -	- -	0.3	- -

As was stated in Section 6.2.4, the total CR across all media and exposure routes was 6.1E-04, 6.3E-04, 6.1E-04, 6.5E-04, 7.3E-04, 6.2E-04 and 6.6E-04, for the future on-site industrial worker at AOC-B, AOC-E, AOC-F, SWMU-4, SWMU-7, SWMU-9D and SWMU-12, respectively.

In Attachments H1 through H7, Table 9.RME provides the summary of hazards and risks for the current/future on-site construction worker at AOC-B, AOC-E, AOC-F, SWMU-4, SWMU-7, SWMU-9D and SWMU-12, respectively. As was stated in Section 6.1.5, the total HI across all media and exposure routes at each of these AOC/SWMUs was 2.6E+00, 2.8E+00, 2.2E+00, 2.6E+00, 2.2E+00, 2.7E+00 and 2.8E+00, respectively. Target organ HIs for the current/future on-site construction worker at each SWMU/AOC are presented below:

Target Organ	AOC-B	AOC-E	AOC-F	SWMU-4	SWMU-7	SWMU-9D	SWMU-12
Skin	1.0	0.98	0.79	0.79	0.77	1.2	1.0
Brain	0.96	0.94	0.74	0.74	0.74	1.0	0.9
CNS	1.8	1.7	1.5	1.5	1.5	1.8	1.7
Liver	1.4	1.3	1.1	1.1	1.1	1.4	1.3
Immune Func.	1.3	1.6	0.96	1.3	0.96	1.3	1.4
Blood	0.99	0.96	0.76	0.76	0.76	1.0	0.92
Nasal Cavity	0.96	0.93	0.73	0.73	0.73	1.0	0.9
Lung	- -	- -	- -	- -	- -	1.0	- -

As was stated in Section 6.2.5, the total CR across all media and exposure routes was 5.6E-06, 6.7E-06, 5.6E-06, 9.0E-06, 1.4E-05, 6.0E-06 and 9.1E-06, for the current/future on-site construction worker at AOC-B, AOC-E, AOC-F, SWMU-4, SWMU-7, SWMU-9D and SWMU-12, respectively.

In Attachments I1 through I7, Table 9.1RME provides the summary of hazards and risks for the future on-site adult resident at AOC-B, AOC-E, AOC-F, SWMU-4, SWMU-7, SWMU-9D and SWMU-12, respectively. As was stated in Section 6.1.6, the total HI across all media and exposure routes at each of these AOC/SWMUs was 1.2E+01, 1.2E+01, 1.1E+01, 1.1E+01, 1.1E+01, 1.2E+01 and 1.2E+01, respectively. Target organ HIs for the future on-site adult resident at each SWMU/AOC are presented below:

Target Organ	AOC-B	AOC-E	AOC-F	SWMU-4	SWMU-7	SWMU-9D	SWMU-12
Brain	0.72	4.1	0.61	0.66	0.52	0.73	0.69
CNS	4.0	4.0	3.9	3.9	3.8	4.0	4.0
Skin	0.98	1.0	0.87	0.9	0.78	1.1	0.99
Liver	2.9	2.9	2.7	2.8	2.7	2.9	2.8
Immune Func.	4.8	5.1	4.7	4.7	4.6	4.8	5.0
Blood	0.86	0.9	0.76	0.79	0.69	0.88	0.84
Nasal Cavity	1.4	1.5	1.3	1.4	1.3	1.5	1.4
Lung	- -	0.74	- -	- -	- -	- -	- -
Kidney	0.72	- -	- -	- -	- -	- -	- -
GI tract	0.7	0.74	0.6	0.63	0.52	0.72	0.68

As was stated in Section 6.2.6, the total CR across all media and exposure routes was 1.4E-03, 1.4E-03, 1.4E-03, 1.5E-03, 1.6E-03, 1.4E-03 and 1.4E-03, for the future on-site adult resident at AOC-B, AOC-E, AOC-F, SWMU-4, SWMU-7, SWMU-9D and SWMU-12, respectively.

In Attachments I1 through I7, Table 9.2RME provides the summary of hazards for the future on-site child resident at AOC-B, AOC-E, AOC-F, SWMU-4, SWMU-7, SWMU-9D and SWMU-12, respectively. As was stated in Section 6.1.6, the total HI across all media and exposure routes at each of these AOC/SWMUs was 2.5E+01, 2.7E+01, 2.3E+01, 2.3E+01, 2.1E+01, 2.5E+01 and 2.5E+01, respectively. Target organ HIs for the future on-site child resident at each SWMU/AOC are presented below:

Target Organ	AOC-B	AOC-E	AOC-F	SWMU-4	SWMU-7	SWMU-9D	SWMU-12
Brain	3.4	4.0	2.4	2.8	1.6	3.6	3.2
Skin	4.3	4.5	3.2	3.5	2.4	5.0	4.4
CNS	13.0	13.0	12.0	12.0	11.0	13.0	13.0
GI tract	3.2	3.6	2.3	2.6	1.6	3.4	3.1
Liver	10.0	10.0	8.5	8.9	7.7	9.7	9.2
Kidney	3.4	3.6					
Nasal Cavity	3.4	3.8	2.5	2.8	1.8	3.6	3.2
Immune Func.	6.7	9.0	5.6	5.5	4.6	6.7	7.7
Blood	3.7	4.1	2.8	3.1	2.1	3.9	3.6

In Attachments I1 through I7, Table 9.3RME provides the summary of risks for the future on-site lifetime resident at AOC-B, AOC-E, AOC-F, SWMU-4, SWMU-7, SWMU-9D and SWMU-12, respectively. As was stated in Section 6.2.6, the total CR across all media and exposure routes at each of these AOC/SWMUs was 4.1E-03, 4.1E-03, 4.1E-03, 4.2E-03, 4.6E-03, 4.1E-03 and 4.3E-03, respectively.

RAGS Part D requires that non-carcinogenic hazard and carcinogenic risk "drivers" be carried forward onto the Risk Assessment Summary tables as shown on Tables 10.RME through 10.3.RME. *RAGS Part D* defined a non-carcinogenic hazard driver as those COPCs contributing to a target organ-specific HI exceeding unity (1) and a carcinogenic risk driver as those COPCs contributing a CR exceeding 1×10^{-5} toward a total CR exceeding 1×10^{-4} when using RME exposure assumptions.

Attachment A, Table 10.RME show that no non-carcinogenic hazard drivers and no carcinogenic risk drivers were retained for the current/future off-site adolescent trespasser.

Attachment B, Table 10.1.RME shows that no non-carcinogenic hazard drivers and no carcinogenic risk drivers were retained for the current/future off-site adult resident. Attachment B, Table 10.2.RME shows that no carcinogenic risk drivers were retained for the current/future off-site child resident; non-carcinogenic hazard drivers were identified for exposure to surface water (as represented by piezometer data). Attachment B, 10.3.RME shows that no non-carcinogenic hazard drivers were retained for the current/future off-site lifetime resident; carcinogenic risk drivers were identified for exposure to surface water (as represented by piezometer data).

In Attachments F1 through F7, Table 10.RME shows that no non-carcinogenic hazard drivers and no carcinogenic risk drivers were retained for the current on-site industrial worker at any of the AOC/SWMUs except for total TCDD TEC in soil at SWMU-7.

In Attachments G1 through G7, Table 10.RME shows the non-carcinogenic hazard drivers and carcinogenic risk drivers were retained for the future on-site industrial worker, based primarily on the use of on-site ground water for showering.

In Attachments H1 through H7, Table 10.RME shows that no carcinogenic risk drivers were retained for the current/future on-site construction worker; non-carcinogenic hazard drivers were identified for exposure to groundwater, based primarily on the dermal contact of on-site ground water during excavation activities.

In Attachments I1 through I7, Table 10.1RME, 10.2RME and 10.3RME provides the non-carcinogenic hazard and carcinogenic risk drivers for the hypothetical future on-site adult resident, child resident and lifetime resident, respectively. Drivers were identified in soil, ground water and surface water (as represented by piezometer data).

6.4 *ESTIMATION OF NON-CARCINOGENIC HAZARD AND CARCINOGENIC RISK USING CENTRAL TENDENCY EXPOSURE ASSUMPTIONS*

RAGS Part D (USEPA 2001) recommends that central tendency (CT) hazard and risk estimates be calculated to serve as a point of comparison in those cases where unacceptable hazard and risk estimates result when using RME exposure assumptions. *RAGS Part D* (USEPA 2001) also recommends that CT hazard or risk be calculated only in those instances where the hazard or risk presented in Tables App10.RME through App10.3.RME resulted in a target organ-specific HI exceeding unity (1) or a total CR exceeding 1×10^{-4}.

The CT hazard and risk estimates for this risk assessment, based upon CT exposure assumptions, were calculated for the current/future off-site child and lifetime resident, future on-site industrial worker, current/future on-site construction worker and the hypothetical future on-site adult resident, child resident, lifetime resident.

6.4.1 *Current/Future Off-Site Child and Lifetime Resident*

Attachment B, Tables 7.9.CT and 7.10.CT, provide the HQs and HIs calculated for the hypothetical future on-site child resident using CT exposure assumptions. The HIs for the incidental ingestion of surface water, dermal contact with surface water and inhalation of volatiles from surface water (piezometer data) were 7.9E-02, 1.1E-01 and 8.3E-03, respectively, for this receptor using CT exposure assumptions. The total HI across all exposure routes was estimated to be 1.9E-01, below the target HI of unity (1).

Attachment B, Tables 8.11.CT and 8.12.CT provide the CRs calculated for the hypothetical future on-site lifetime resident using CT exposure assumptions. The CRs for the incidental ingestion of surface water, dermal contact with surface water and inhalation of volatiles from surface water (piezometer data) were 4.3E-06, 3.5E-05 and 2.3E-06, respectively, for this receptor using CT exposure assumptions. The total CR across all exposure routes is within the NCP acceptable risk range of 1×10^{-6} to 1×10^{-4}.

6.4.2 *Future On-Site Industrial Worker*

For the future on-site industrial worker exposure, HIs and CRs calculated for each AOC/SWMU soil area were added to the HIs and CRs calculated for hypothetical on-site industrial worker exposure to ground water. In Attachments G1 through G7, Tables 7.1.CT, 7.2.CT, 8.1.CT and 8.2.CT (where applicable) provide the HIs, HQs and CRs calculated separately for each soil AOC/SWMU for the future on-site industrial worker using CT exposure assumptions. Attachment D, Tables 7.6.CT, 7.7.CT, 8.6.CT and 8.7.CT (where applicable) provide the HIs, HQs, and CRs calculated for the future on-site industrial worker exposure to ground water using CT exposure assumptions. HIs and HQs using CT exposure assumptions are shown in the table below for the future on-site industrial worker.

Future On-site Industrial Worker - CT	Ingestion HQ (Table Ref.)	Dermal HQ (Table Ref.)	Inhalation HQ (Table Ref.)	CT HI
AOC-B Soil	1.1E-01 (AttG1,7.1.CT)	3.2E-02 (AttG1,7.1.CT)	No CT*	1.4E-01
Ground Water	1.7E-01 (AttD,7.6.CT)	3.5E-02 (AttD,7.6.CT)	4.3E-02 (AttD,7.7.CT)	2.5E-01
AOC B Total Exposure				**3.9E-01**
AOC-E Soil	9.0E-02 (AttG2,7.1.CT)	4.2E-02 (AttG2,7.1.CT)	No CT*	1.3E-01
Ground Water	1.7E-01 (AttD,7.6.CT)	3.5E-02 (AttD,7.6.CT)	4.3E-02 (AttD,7.7.CT)	2.5E-01
AOC E Total Exposure				**3.8E-01**
AOC-F Soil	8.0E-03 (AttG3,7.1.CT)	3.2E-03 (AttG3,7.1.CT)	No CT*	1.1E-02
Ground Water	1.7E-01 (AttD,7.6.CT)	3.5E-02 (AttD,7.6.CT)	4.3E-02 (AttD,7.7.CT)	2.5E-01
AOC F Total Exposure				**2.6E-01**
SWMU-4 Soil	7.5E-03 (AttG4,7.1.CT)	2.9E-03 (AttG4,7.1.CT)	4.5E-03 (AttG4,7.2.CT)	1.5E-02
Ground Water	1.7E-01 (AttD,7.6.CT)	3.5E-02 (AttD,7.6.CT)	4.3E-02 (AttD,7.7.CT)	2.5E-01
SWMU-4 Total Exposure				**2.7E-01**
SWMU-7 Soil	No CT*	No CT*	No CT*	0.0E+00
Ground Water	1.7E-01 (AttD,7.6.CT)	3.5E-02 (AttD,7.6.CT)	4.3E-02 (AttD,7.7.CT)	2.5E-01
SWMU-7 Total Exposure				**2.5E-01**
SWMU-9D Soil	1.3E-01 (AttG6,7.1.CT)	2.7E-02 (AttG6,7.1.CT)	1.4E-05 (AttG6,7.2.CT)	1.6E-01
Ground Water	1.7E-01 (AttD,7.6.CT)	3.5E-02 (AttD,7.6.CT)	4.3E-02 (AttD,7.7.CT)	2.5E-01
SWMU-9D Total Exposure				**4.1E-01**
SWMU-12 Soil	1.2E-01 (AttG7,7.1.CT)	6.3E-02 (AttG7,7.1.CT)	1.6E-04 (AttG7,7.2.CT)	1.9E-01
Ground Water	1.7E-01 (AttD,7.6.CT)	3.5E-02 (AttD,7.6.CT)	4.3E-02 (AttD,7.7.CT)	2.5E-01
SWMU-12 Total Exposure				**4.3E-01**

* No CT: No RME drivers retained; therefore, CT calculation not required.

The total HI across all exposure routes at each AOC/SWMU was estimated to be below the target HI of unity (1) using CT exposure assumptions.

CRs using CT exposure assumptions are shown in the table below for the future on-site industrial worker.

Future On-site Industrial Worker - CT	Ingestion CR (Table Ref.)	Dermal CR (Table Ref.)	Inhalation CR (Table Ref.)	CT CR
AOC-B Soil	No CT*	No CT*	No CT*	0.0E+00
Ground Water	7.4E-06 (AttD,8.6.CT)	1.1E-05 (AttD,8.6.CT)	8.4E-06 (AttD,8.7.CT)	2.7E-05
AOC B Total Exposure				**2.7E-05**
AOC-E Soil	No CT*	No CT*	No CT*	0.0E+00
Ground Water	7.4E-06 (AttD,8.6.CT)	1.1E-05 (AttD,8.6.CT)	8.4E-06 (AttD,8.7.CT)	2.7E-05
AOC E Total Exposure				**2.7E-05**
AOC-F Soil	No CT*	No CT*	No CT*	0.0E+00
Ground Water	7.4E-06 (AttD,8.6.CT)	1.1E-05 (AttD,8.6.CT)	8.4E-06 (AttD,8.7.CT)	2.7E-05
AOC F Total Exposure				**2.7E-05**
SWMU-4 Soil	No CT*	No CT*	No CT*	0.0E+00
Ground Water	7.4E-06 (AttD,8.6.CT)	1.1E-05 (AttD,8.6.CT)	8.4E-06 (AttD,8.7.CT)	2.7E-05
SWMU-4 Total Exposure				**2.7E-05**
SWMU-7 Soil	1.2E-05 (AttG5,8.1.CT)	4.6E-06 (AttG5,8.1.CT)	No CT*	1.7E-05
Ground Water	7.4E-06 (AttD,8.6.CT)	1.1E-05 (AttD,8.6.CT)	8.4E-06 (AttD,8.7.CT)	2.7E-05
SWMU-7 Total Exposure				**4.4E-05**
SWMU-9D Soil	No CT*	No CT*	No CT*	0.0E+00
Ground Water	7.4E-06 (AttD,8.6.CT)	1.1E-05 (AttD,8.6.CT)	8.4E-06 (AttD,8.7.CT)	2.7E-05
SWMU-9D Total Exposure				**2.7E-05**
SWMU-12 Soil	8.6E-06 (AttG7,8.1.CT)	5.7E-06 (AttG7,8.1.CT)	No CT*	1.4E-05
Ground Water	7.4E-06 (AttD,8.6.CT)	1.1E-05 (AttD,8.6.CT)	8.4E-06 (AttD,8.7.CT)	2.7E-05
SWMU-12 Total Exposure				**4.1E-05**

* No CT: No RME drivers retained; therefore, CT calculation not required.

The total CR across all exposure routes at each AOC/SWMU is within the NCP acceptable risk range of 1 x 10^{-6} to 1 x 10^{-4} using CT exposure assumptions.

6.4.3 *Current/Future On-Site Construction Worker*

For the current/future on-site construction worker exposure, HIs calculated for each AOC/SWMU soil area were added to the HIs for the current/future on-site construction worker exposure to ground water. In Attachments H1 through H7, Tables 7.1.CT and 7.2.CT (where applicable) provide the HIs and HQs calculated separately for each soil AOC/SWMU for the current/future on-site construction worker using CT exposure assumptions. Attachment E, Tables 7.1.CT and 7.2.CT (where applicable) provide the HIs and HQs calculated for the current/future on-site construction worker exposure to ground water using CT exposure assumptions. HIs and HQs using CT exposure assumptions are shown in the table below for the current/future on-site construction worker.

Current/Future On-site	Ingestion HQ	Dermal HQ	Inhalation HQ	CT HI

Construction Worker - CT	(Table Ref.)	(Table Ref.)	(Table Ref.)	
AOC-B Soil	2.2E-01 (AttH1,7.1.CT)	3.2E-02 (AttH1,7.1.CT)	No CT*	2.5E-01
Ground Water	3.7E-01 (AttE,7.1.CT)	6.6E-01 (AttE,7.1.CT)	1.2E-05 (AttE,7.2.CT)	1.0E+00
AOC B Total Exposure				**1.3E+00**
AOC-E Soil	1.8E-01 (AttH2,7.1.CT)	4.2E-02 (AttH2,7.1.CT)	No CT*	2.2E-01
Ground Water	3.7E-01 (AttE,7.1.CT)	6.6E-01 (AttE,7.1.CT)	1.2E-05 (AttE,7.2.CT)	1.0E+00
AOC E Total Exposure				**1.2E+00**
AOC-F Soil	No CT*	No CT*	No CT*	0.0E+00
Ground Water	3.7E-01 (AttE,7.1.CT)	6.6E-01 (AttE,7.1.CT)	1.2E-05 (AttE,7.2.CT)	1.0E+00
AOC F Total Exposure				**1.0E+00**
SWMU-4 Soil	No CT*	No CT*	No CT*	0.0E+00
Ground Water	3.7E-01 (AttE,7.1.CT)	6.6E-01 (AttE,7.1.CT)	1.2E-05 (AttE,7.2.CT)	1.0E+00
SWMU-4 Total Exposure				**1.0E+00**
SWMU-7 Soil	No CT*	No CT*	No CT*	0.0E+00
Ground Water	3.7E-01 (AttE,7.1.CT)	6.6E-01 (AttE,7.1.CT)	1.2E-05 (AttE,7.2.CT)	1.0E+00
SWMU-7 Total Exposure				**1.0E+00**
SWMU-9D Soil	2.6E-01 (AttH6,7.1.CT)	2.7E-02 (AttH6,7.1.CT)	No CT*	2.9E-01
Ground Water	3.7E-01 (AttE,7.1.CT)	6.6E-01 (AttE,7.1.CT)	1.2E-05 (AttE,7.2.CT)	1.0E+00
SWMU-9D Total Exposure				**1.3E+00**
SWMU-12 Soil	No CT*	No CT*	No CT*	0.0E+00
Ground Water	3.7E-01 (AttE,7.1.CT)	6.6E-01 (AttE,7.1.CT)	1.2E-05 (AttE,7.2.CT)	1.0E+00
SWMU-12 Total Exposure				**1.0E+00**

* No CT: No RME drivers retained; therefore, CT calculation not required.

The total HI for the current/future on-site construction worker across all exposure routes at each AOC/SWMU was estimated to be equal to or just above the target HI of unity (1) using CT exposure assumptions.

6.4.4 *Future On-site Adult, Child and Lifetime Resident*

For the hypothetical future on-site resident exposure, HIs for calculated for each AOC/SWMU soil area were added to the HIs calculated for exposure to on-site ground water as well as sediment and surface water (represented by piezometer data) in Red Clay Creek using CT exposure assumptions. In Attachments I1 through I7, Tables 7.1.CT through 7.6.CT (where applicable) provide the HQs and HIs calculated separately for each soil AOC/SWMU for the hypothetical future on-site adult and child resident using CT exposure assumptions. Attachment D, Tables 7.1.CT through 7.3.CT (where applicable) provide the HQs and HIs calculated for the hypothetical future on-site adult and child resident exposure to ground water using CT exposure assumptions. Attachment C, Tables 7.1.CT through 7.12.CT (where applicable) provide HQs and HIs calculated for hypothetical future on-site resident exposure to sediment and surface water (represented by piezometer data) in Red Clay Creek using CT exposure assumptions.

HIs are shown in the table below for the hypothetical future on-site adult resident using CT exposure assumptions.

Future On-site Adult Resident - CT	**Ingestion HQ (Table Ref.)**	**Dermal HQ (Table Ref.)**	**Inhalation HQ (Table Ref.)**	**CT HI**
AOC-B Soil	1.6E-01 (AttI1,7.1.CT)	2.8E-03 (AttI1,7.1.CT)	3.1E-04 (AttI1,7.2.CT)	1.6E-01
Ground Water	1.7E+00 (AttD,7.1.CT)	2.1E-01 (AttD,7.1.CT)	2.5E-01 (AttD,7.2.CT)	2.2E+00
Sediment	6.3E-05 (AttC,7.1.CT)	1.5E-05 (AttC,7.1.CT)	No CT*	7.8E-05
Surface Water (piezometer)	6.5E-02 (AttC,7.7.CT)	1.7E-01 (AttC,7.7.CT)	2.2E-02 (AttC,7.8.CT)	2.6E-01
AOC B Total Exposure				**2.6E+00**
AOC-E Soil	1.8E-01 (AttI2,7.1.CT)	3.2E-03 (AttI2,7.1.CT)	3.5E-04 (AttI2,7.2.CT)	1.8E-01
Ground Water	1.7E+00 (AttD,7.1.CT)	2.1E-01 (AttD,7.1.CT)	2.5E-01 (AttD,7.2.CT)	2.2E+00
Sediment	6.3E-05 (AttC,7.1.CT)	1.5E-05 (AttC,7.1.CT)	No CT*	7.8E-05
Surface Water (piezometer)	6.5E-02 (AttC,7.7.CT)	1.7E-01 (AttC,7.7.CT)	2.2E-02 (AttC,7.8.CT)	2.6E-01
AOC E Total Exposure				**2.6E+00**
AOC-F Soil	8.3E-02 (AttI3,7.1.CT)	1.3E-03 (AttI3,7.1.CT)	2.0E-04 (AttI3,7.2.CT)	8.4E-02
Ground Water	1.7E+00 (AttD,7.1.CT)	2.1E-01 (AttD,7.1.CT)	2.5E-01 (AttD,7.2.CT)	2.2E+00
Sediment	6.3E-05 (AttC,7.1.CT)	1.5E-05 (AttC,7.1.CT)	No CT*	7.8E-05
Surface Water (piezometer)	6.5E-02 (AttC,7.7.CT)	1.7E-01 (AttC,7.7.CT)	2.2E-02 (AttC,7.8.CT)	2.6E-01
AOC F Total Exposure				**2.5E+00**
SWMU-4 Soil	1.1E-01 (AttI4,7.1.CT)	2.2E-04 (AttI4,7.1.CT)	3.3E-03 (AttI4,7.2.CT)	1.1E-01
Ground Water	1.7E+00 (AttD,7.1.CT)	2.1E-01 (AttD,7.1.CT)	2.5E-01 (AttD,7.2.CT)	2.2E+00
Sediment	6.3E-05 (AttC,7.1.CT)	1.5E-05 (AttC,7.1.CT)	No CT*	7.8E-05
Surface Water (piezometer)	6.5E-02 (AttC,7.7.CT)	1.7E-01 (AttC,7.7.CT)	2.2E-02 (AttC,7.8.CT)	2.6E-01
SWMU-4 Total Exposure				**2.6E+00**
SWMU-7 Soil	No CT*	No CT*	No CT*	0.0E+00
Ground Water	1.7E+00 (AttD,7.1.CT)	2.1E-01 (AttD,7.1.CT)	2.5E-01 (AttD,7.2.CT)	2.2E+00
Sediment	6.3E-05 (AttC,7.1.CT)	1.5E-05 (AttC,7.1.CT)	No CT*	7.8E-05
Surface Water (piezometer)	6.5E-02 (AttC,7.7.CT)	1.7E-01 (AttC,7.7.CT)	2.2E-02 (AttC,7.8.CT)	2.6E-01
SWMU-7 Total Exposure				**2.5E+00**
SWMU-9D Soil	1.6E-01 (AttI6,7.1.CT)	2.1E-03 (AttI6,7.1.CT)	2.9E-04 (AttI6,7.2.CT)	1.6E-01
Ground Water	1.7E+00 (AttD,7.1.CT)	2.1E-01 (AttD,7.1.CT)	2.5E-01 (AttD,7.2.CT)	2.2E+00
Sediment	6.3E-05 (AttC,7.1.CT)	1.5E-05 (AttC,7.1.CT)	No CT*	7.8E-05
Surface Water (piezometer)	6.5E-02 (AttC,7.7.CT)	1.7E-01 (AttC,7.7.CT)	2.2E-02 (AttC,7.8.CT)	2.6E-01
SWMU-9D Total Exposure				**2.6E+00**
SWMU-12 Soil	1.6E-01 (AttI7,7.1.CT)	4.7E-03 (AttI7,7.1.CT)	1.7E-04 (AttI7,7.2.CT)	1.6E-01
Ground Water	1.7E+00 (AttD,7.1.CT)	2.1E-01 (AttD,7.1.CT)	2.5E-01 (AttD,7.2.CT)	2.2E+00
Sediment	6.3E-05 (AttC,7.1.CT)	1.5E-05 (AttC,7.1.CT)	No CT*	7.8E-05
Surface Water (piezometer)	6.5E-02 (AttC,7.7.CT)	1.7E-01 (AttC,7.7.CT)	2.2E-02 (AttC,7.8.CT)	2.6E-01

SWMU-12 Total Exposure				**2.6E+00**

* No CT: No RME drivers retained; therefore, CT calculation not required.

The total HI for the hypothetical future on-site adult resident across all exposure routes at each AOC/SWMU was estimated to be above the target HI of unity (1) using CT exposure assumptions (driven primarily by use of on-site ground water).

HIs are shown in the table below for the hypothetical future on-site child resident using CT exposure assumptions.

Future On-site Child Resident - CT	Ingestion HQ (Table Ref.)	Dermal HQ (Table Ref.)	Inhalation HQ (Table Ref.)	CT HI
AOC-B Soil	1.5E+00 (AttI1,7.3.CT)	2.9E-02 (AttI1,7.3.CT)	1.4E-03 (AttI1,7.4.CT)	1.5E+00
Ground Water	5.2E+00 (AttD,7.3.CT)	4.5E-01 (AttD,7.3.CT)	No CT*	5.7E+00
Sediment	5.8E-04 (AttB,7.3.CT)	9.7E-05 (AttB,7.3.CT)	No CT*	6.8E-04
Surface Water (piezometer)	1.0E-01 (AttB,7.9.CT)	1.3E-01 (AttB,7.9.CT)	4.8E-02 (AttB,7.10.CT)	2.8E-01
AOC B Total Exposure				**7.5E+00**
AOC-E Soil	1.6E+00 (AttI2,7.3.CT)	3.3E-02 (AttI2,7.3.CT)	1.6E-03 (AttI2,7.4.CT)	1.7E+00
Ground Water	5.2E+00 (AttD,7.3.CT)	4.5E-01 (AttD,7.3.CT)	No CT*	5.7E+00
Sediment	5.8E-04 (AttB,7.3.CT)	9.7E-05 (AttB,7.3.CT)	No CT*	6.8E-04
Surface Water (piezometer)	1.0E-01 (AttB,7.9.CT)	1.3E-01 (AttB,7.9.CT)	4.8E-02 (AttB,7.10.CT)	2.8E-01
AOC E Total Exposure				**7.7E+00**
AOC-F Soil	7.7E-01 (AttI3,7.3.CT)	1.4E-02 (AttI3,7.3.CT)	9.5E-04 (AttI3,7.4.CT)	7.8E-01
Ground Water	5.2E+00 (AttD,7.3.CT)	4.5E-01 (AttD,7.3.CT)	No CT*	5.7E+00
Sediment	5.8E-04 (AttB,7.3.CT)	9.7E-05 (AttB,7.3.CT)	No CT*	6.8E-04
Surface Water (piezometer)	1.0E-01 (AttB,7.9.CT)	1.3E-01 (AttB,7.9.CT)	4.8E-02 (AttB,7.10.CT)	2.8E-01
AOC F Total Exposure				**6.8E+00**
SWMU-4 Soil	1.0E+00 (AttI4,7.3.CT)	2.3E-03 (AttI4,7.3.CT)	1.5E-02 (AttI4,7.4.CT)	1.0E+00
Ground Water	5.2E+00 (AttD,7.3.CT)	4.5E-01 (AttD,7.3.CT)	No CT*	5.7E+00
Sediment	5.8E-04 (AttB,7.3.CT)	9.7E-05 (AttB,7.3.CT)	No CT*	6.8E-04
Surface Water (piezometer)	1.0E-01 (AttB,7.9.CT)	1.3E-01 (AttB,7.9.CT)	4.8E-02 (AttB,7.10.CT)	2.8E-01
SWMU-4 Total Exposure				**7.0E+00**
SWMU-7 Soil	No CT*	No CT*	No CT*	0.0E+00
Ground Water	5.2E+00 (AttD,7.3.CT)	4.5E-01 (AttD,7.3.CT)	No CT*	5.7E+00
Sediment	5.8E-04 (AttB,7.3.CT)	9.7E-05 (AttB,7.3.CT)	No CT*	6.8E-04
Surface Water (piezometer)	1.0E-01 (AttB,7.9.CT)	1.3E-01 (AttB,7.9.CT)	4.8E-02 (AttB,7.10.CT)	2.8E-01
SWMU-7 Total Exposure				**6.0E+00**
SWMU-9D Soil	1.4E+00 (AttI6,7.3.CT)	2.1E-02 (AttI6,7.3.CT)	1.3E-03 (AttI6,7.4.CT)	1.5E+00
Ground Water	5.2E+00 (AttD,7.3.CT)	4.5E-01 (AttD,7.3.CT)	No CT*	5.7E+00
Sediment	5.8E-04 (AttB,7.3.CT)	9.7E-05 (AttB,7.3.CT)	No CT*	6.8E-04

Surface Water (piezometer)	1.0E-01 (AttB,7.9.CT)	1.3E-01 (AttB,7.9.CT)	4.8E-02 (AttB,7.10.CT)	2.8E-01
SWMU-9D Total Exposure				**7.5E+00**
SWMU-12 Soil	1.4E+00 (AttI7,7.3.CT)	4.9E-02 (AttI7,7.3.CT)	7.9E-04 (AttI7,7.4.CT)	1.5E+00
Ground Water	5.2E+00 (AttD,7.3.CT)	4.5E-01 (AttD,7.3.CT)	No CT*	5.7E+00
Sediment	5.8E-04 (AttB,7.3.CT)	9.7E-05 (AttB,7.3.CT)	No CT*	6.8E-04
Surface Water (piezometer)	1.0E-01 (AttB,7.9.CT)	1.3E-01 (AttB,7.9.CT)	4.8E-02 (AttB,7.10.CT)	2.8E-01
SWMU-12 Total Exposure				**7.5E+00**

* No CT: No RME drivers retained; therefore, CT calculation not required.

The total HI for the hypothetical future on-site child resident across all exposure routes at each AOC/SWMU was estimated to be above the target HI of unity (1) using CT exposure assumptions.

For the hypothetical future on-site resident exposure, CRs for calculated for each AOC/SWMU soil area were added to the CRs calculated for exposure to on-site ground water as well as sediment and surface water (represented by piezometer data) in Red Clay Creek using CT exposure assumptions. In Attachments I1 through I7, Tables 8.1.CT through 8.6.CT (where applicable) provide the CRs calculated separately for each soil AOC/SWMU for the hypothetical future on-site adult and lifetime resident using CT exposure assumptions. Attachment D, Tables 8.1.CT through 8.3.CT (where applicable) provide the CRs calculated for the hypothetical future on-site adult and lifetime resident exposure to ground water using CT exposure assumptions. Attachment C, Tables 8.1.CT through 8.12.CT (where applicable) provide CRs calculated for hypothetical future on-site adult and lifetime resident exposure to sediment and surface water (represented by piezometer data) in Red Clay Creek using CT exposure assumptions.

CRs are shown in the table below for the hypothetical future on-site adult resident using CT exposure assumptions.

Future On-site Adult Resident - CT	Ingestion CR (Table Ref.)	Dermal CR (Table Ref.)	Inhalation CR (Table Ref.)	CT CR
AOC-B Soil	1.5E-06 (AttI1,8.1.CT)	8.9E-08 (AttI1,8.1.CT)	No CT*	1.6E-06
Ground Water	2.6E-05 (AttD,8.1.CT)	2.1E-05 (AttD,8.1.CT)	5.8E-05 (AttD,8.2.CT)	1.0E-04
Sediment	No CT*	No CT*	No CT*	0.0E+00
Surface Water (piezometer)	1.3E-06 (AttB,8.7.CT)	1.5E-05 (AttB,8.7.CT)	No CT*	1.6E-05
AOC B Total Exposure				**1.2E-04**
AOC-E Soil	5.7E-07 (AttI2,8.1.CT)	4.9E-08 (AttI2,8.1.CT)	No CT*	6.2E-07
Ground Water	2.6E-05 (AttD,8.1.CT)	2.1E-05 (AttD,8.1.CT)	5.8E-05 (AttD,8.2.CT)	1.0E-04
Sediment	No CT*	No CT*	No CT*	0.0E+00
Surface Water (piezometer)	1.3E-06 (AttB,8.7.CT)	1.5E-05 (AttB,8.7.CT)	No CT*	1.6E-05
AOC E Total Exposure				**1.2E-04**

AOC-F Soil	1.8E-06 (AttI3,8.1.CT)	1.9E-07 (AttI3,8.1.CT)	No CT*	2.0E-06
Ground Water	2.6E-05 (AttD,8.1.CT)	2.1E-05 (AttD,8.1.CT)	5.8E-05 (AttD,8.2.CT)	1.0E-04
Sediment	No CT*	No CT*	No CT*	0.0E+00
Surface Water (piezometer)	1.3E-06 (AttB,8.7.CT)	1.5E-05 (AttB,8.7.CT)	No CT*	1.6E-05
AOC F Total Exposure				**1.2E-04**
SWMU-4 Soil	2.5E-06 (AttI4,8.1.CT)	1.6E-07 (AttI4,8.1.CT)	9.1E-08 (AttI4,8.2.CT)	2.8E-06
Ground Water	2.6E-05 (AttD,8.1.CT)	2.1E-05 (AttD,8.1.CT)	5.8E-05 (AttD,8.2.CT)	1.0E-04
Sediment	No CT*	No CT*	No CT*	0.0E+00
Surface Water (piezometer)	1.3E-06 (AttB,8.7.CT)	1.5E-05 (AttB,8.7.CT)	No CT*	1.6E-05
SWMU-4 Total Exposure				**1.2E-04**
SWMU-7 Soil	1.7E-05 (AttI5,8.1.CT)	4.0E-06 (AttI5,8.1.CT)	No CT*	2.1E-05
Ground Water	2.6E-05 (AttD,8.1.CT)	2.1E-05 (AttD,8.1.CT)	5.8E-05 (AttD,8.2.CT)	1.0E-04
Sediment	No CT*	No CT*	No CT*	0.0E+00
Surface Water (piezometer)	1.3E-06 (AttB,8.7.CT)	1.5E-05 (AttB,8.7.CT)	No CT*	1.6E-05
SWMU-7 Total Exposure				**1.4E-04**
SWMU-9D Soil	2.1E-06 (AttI6,8.1.CT)	7.5E-08 (AttI6,8.1.CT)	No CT*	2.2E-06
Ground Water	2.6E-05 (AttD,8.1.CT)	2.1E-05 (AttD,8.1.CT)	5.8E-05 (AttD,8.2.CT)	1.0E-04
Sediment	No CT*	No CT*	No CT*	0.0E+00
Surface Water (piezometer)	1.3E-06 (AttB,8.7.CT)	1.5E-05 (AttB,8.7.CT)	No CT*	1.6E-05
SWMU-9D Total Exposure				**1.2E-04**
SWMU-12 Soil	4.9E-06 (AttI7,8.1.CT)	2.5E-07 (AttI7,8.1.CT)	No CT*	5.1E-06
Ground Water	2.6E-05 (AttD,8.1.CT)	2.1E-05 (AttD,8.1.CT)	5.8E-05 (AttD,8.2.CT)	1.0E-04
Sediment	No CT*	No CT*	No CT*	0.0E+00
Surface Water (piezometer)	1.3E-06 (AttB,8.7.CT)	1.5E-05 (AttB,8.7.CT)	No CT*	1.6E-05
SWMU-12 Total Exposure				**1.2E-04**

* No CT: No RME drivers retained; therefore, CT calculation not required.

The total CR across all exposure routes at each AOC/SWMU is just above the NCP acceptable risk range of 1 x 10^{-6} to 1 x 10^{-4} for the hypothetical future on-site adult resident using CT exposure assumptions (driven primarily by use of on-site ground water).

CRs are shown in the table below for the hypothetical future on-site lifetime resident using CT exposure assumptions.

Future On-site Child/Adult Resident - CT	Ingestion CR (Table Ref.)	Dermal CR (Table Ref.)	Inhalation CR (Table Ref.)	CT CR
AOC-B Soil	1.5E-05 (AttI1,8.5.CT)	6.3E-06 (AttI1,8.5.CT)	No CT*	2.1E-05
Ground Water	2.4E-04 (AttD,8.4.CT)	1.5E-05 (AttD,8.4.CT)	1.6E-04 (AttD,8.5.CT)	5.8E-04
Sediment	No CT*	No CT*	No CT*	0.0E+00
Surface Water (piezometer)	1.4E-06 (AttB,8.11.CT)	1.5E-05 (AttB,8.11.CT)	2.3E-06 (AttB,8.12.CT)	1.8E-05
AOC B Total Exposure				**6.1E-04**
AOC-E Soil	3.6E-05 (AttI2,8.5.CT)	2.4E-05 (AttI2,8.5.CT)	No CT*	6.0E-05

Ground Water	2.4E-04 (AttD,8.4.CT)	1.5E-05 (AttD,8.4.CT)	1.6E-04 (AttD,8.5.CT)	5.8E-04
Sediment	No CT*	No CT*	No CT*	0.0E+00
Surface Water (piezometer)	1.4E-06 (AttB,8.11.CT)	1.5E-05 (AttB,8.11.CT)	2.3E-06 (AttB,8.12.CT)	1.8E-05
AOC E Total Exposure				**6.1E-04**
AOC-F Soil	1.8E-05 (AttI3,8.5.CT)	7.1E-06 (AttI3,8.5.CT)	No CT*	2.5E-05
Ground Water	2.4E-04 (AttD,8.4.CT)	1.5E-05 (AttD,8.4.CT)	1.6E-04 (AttD,8.5.CT)	5.8E-04
Sediment	No CT*	No CT*	No CT*	0.0E+00
Surface Water (piezometer)	1.4E-06 (AttB,8.11.CT)	1.5E-05 (AttB,8.11.CT)	2.3E-06 (AttB,8.12.CT)	1.8E-05
AOC F Total Exposure				**6.2E-04**
SWMU-4 Soil	2.5E-05 (AttI4,8.5CT)	1.2E-05 (AttI4,8.5CT)	8.0E-07 (AttI4,8.6CT)	3.8E-05
Ground Water	2.4E-04 (AttD,8.4.CT)	1.5E-05 (AttD,8.4.CT)	1.6E-04 (AttD,8.5.CT)	5.8E-04
Sediment	No CT*	No CT*	No CT*	0.0E+00
Surface Water (piezometer)	1.4E-06 (AttB,8.11.CT)	1.5E-05 (AttB,8.11.CT)	2.3E-06 (AttB,8.12.CT)	1.8E-05
SWMU-4 Total Exposure				**6.4E-04**
SWMU-7 Soil	6.0E-05 (AttI5,8.5.CT)	1.2E-05 (AttI5,8.5.CT)	No CT*	7.2E-05
Ground Water	2.4E-04 (AttD,8.4.CT)	1.5E-05 (AttD,8.4.CT)	1.6E-04 (AttD,8.5.CT)	5.8E-04
Sediment	No CT*	No CT*	No CT*	0.0E+00
Surface Water (piezometer)	1.4E-06 (AttB,8.11.CT)	1.5E-05 (AttB,8.11.CT)	2.3E-06 (AttB,8.12.CT)	1.8E-05
SWMU-7 Total Exposure				**6.7E-04**
SWMU-9D Soil	2.1E-05 (AttI6,8.5.CT)	5.3E-06 (AttI6,8.5.CT)	No CT*	2.7E-05
Ground Water	2.4E-04 (AttD,8.4.CT)	1.5E-05 (AttD,8.4.CT)	1.6E-04 (AttD,8.5.CT)	5.8E-04
Sediment	No CT*	No CT*	No CT*	0.0E+00
Surface Water (piezometer)	1.4E-06 (AttB,8.11.CT)	1.5E-05 (AttB,8.11.CT)	2.3E-06 (AttB,8.12.CT)	1.8E-05
SWMU-9D Total Exposure				**6.3E-04**
SWMU-12 Soil	5.0E-05 (AttI7,8.5.CT)	1.7E-05 (AttI7,8.5.CT)	No CT*	6.7E-05
Ground Water	2.4E-04 (AttD,8.4.CT)	1.5E-05 (AttD,8.4.CT)	1.6E-04 (AttD,8.5.CT)	5.8E-04
Sediment	No CT*	No CT*	No CT*	0.0E+00
Surface Water (piezometer)	1.4E-06 (AttB,8.11.CT)	1.5E-05 (AttB,8.11.CT)	2.3E-06 (AttB,8.12.CT)	1.8E-05
SWMU-12 Total Exposure				**6.7E-04**

* No CT: No RME drivers retained; therefore, CT calculation not required.

The total CR across all exposure routes at each AOC/SWMU is above the NCP acceptable risk range of 1 x 10^{-6} to 1 x 10^{-4} for the hypothetical future on-site lifetime resident using CT exposure assumptions (driven primarily by use of on-site ground water and soil exposure at SWMU-7).

6.5 SUMMARY OF NON-CARCINOGENIC HAZARD AND CARCINOGENIC RISK USING CENTRAL TENDENCY EXPOSURE ASSUMPTIONS

Tables 9.CT through 9.3.CT in each Attachment summarize the non-carcinogenic hazards and carcinogenic risk estimated for the four receptor populations evaluated in the HHRA using CT exposure assumptions, as shown in detail on Tables 7.1.CT through 7.12.CT and Tables 8.1.CT through 8.12.CT, respectively (where applicable). It should be noted that Tables 9.2.CT through 9.3.CT present only those COPCs defined as drivers, and therefore may show fewer COPCs than what is shown in the detailed calculation tables (Tables 7.1.CT through 7.12.CT, and Tables 8.1.CT through 8.12.CT, where applicable) presented in Section 6.4. The four receptor populations evaluated using CT exposure assumptions included the:

- current/future off-site child and lifetime resident;
- future on-site industrial worker;
- current/future on-site construction worker; and
- hypothetical future on-site residents (adult, child, lifetime).

Attachment B, Tables 9.2.CT and 9.3.CT provide the summary of hazards and risks for the current/future off-site child and lifetime resident, respectively, using CT exposure assumptions. The total HI across all media and exposure routes was 1.9E-01 and for the child resident. The total CR across all media and exposure routes was 2.9E-05 for the lifetime resident. Attachment B, Table 10.2.CT and Table 10.3.CT show that no non-carcinogenic hazard drivers and no carcinogenic risk drivers were retained for the current/future off-site child and lifetime resident using CT exposure assumptions.

In Attachments G1 through G7, Table 9.CT provides the summary of hazards and risks for the future on-site industrial worker at AOC-B, AOC-E, AOC-F, SWMU-4, SWMU-7, SWMU-9D and SWMU-12, respectively, using CT exposure assumptions. The total HI across all media and exposure routes at each of these AOC/SWMUs was 3.7E-01, 3.6E-01, 2.0E-01, 1.9E-01, 1.9E-01, 3.8E-01 and 3.8E-01, respectively. As was stated in Section 6.2.4, the total CR across all media and exposure routes was 2.5E-05, 2.5E-05, 2.5E-05, 2.5E-05, 2.6E-05, 2.5E-05 and 4.0E-05, respectively. In Attachments G1 through G7, Table 10.CT show that no non-carcinogenic hazard drivers and no carcinogenic risk drivers were retained for the future on-site industrial worker using CT exposure assumptions.

In Attachments H1 through H7, Table 9.CT shows that no carcinogenic risk drivers were retained for the current/future on-site construction worker. AOC/SWMUs where the total HI was just above the target HI of unity (1) across all exposure routes for the current/future on-site construction worker using CT exposure assumptions included: AOC-B

(HI = 1.2), AOC-E (HI = 1.2) and SWMU-9D (HI = 1.3). As shown on Table 9.CT in Attachment H1, at AOC-B, the total CNS HI was 0.99, the total liver HI was 0.53, and the total immune function HI was 0.49. As shown on Table 9.CT in Attachment H2, at AOC-E, the total CNS HI was 0.95, the total liver HI was 0.48, and the total immune function HI was 0.48. As shown on Table 9.CT in Attachment H6, at SWMU-9D, the total skin HI was 0.5, the total CNS HI was 1.0, the total liver HI was 0.54, and the total immune function HI was 0.48. In Attachments H1 through H7, Table 10.CT show that no non-carcinogenic hazard drivers and no carcinogenic risk drivers were retained for the current/future on-site construction worker using CT exposure assumptions.

In Attachments I1 through I7, Table 9.1.CT provides the summary of hazards and risks for the future on-site adult resident at AOC-B, AOC-E, AOC-F, SWMU-4, SWMU-7, SWMU-9D and SWMU-12, respectively, using CT exposure assumptions. The total HI across all media and exposure routes at each of these AOC/SWMUs was 2.4E+00, 2.5E+00, 2.3E+00, 2.4E+00, 2.7E+00, 2.5E+00, and 2.5E+00, respectively. Target organ HIs for the future on-site adult resident under CT exposure conditions at each SWMU/AOC are presented below:

Target Organ	AOC-B	AOC-E	AOC-F	SWMU-4	SWMU-7	SWMU-9D	SWMU-12
Brain	- -	1.7	- -	- -	- -	- -	- -
CNS	1.6	1.6	1.6	1.6	1.7	1.6	1.6
Skin	- -	- -	- -	- -	- -	0.33	- -
Liver	0.61	0.62	0.56	0.59	0.59	0.6	0.59
Immune Func.	0.5	0.52	0.45	0.46	0.39	0.49	0.51
Nasal Cavity	0.25	0.26	0.21	0.22	0.16	0.25	0.24

The total CR across all media and exposure routes was 1.1E-04, 1.2E-04, 1.1E-04, 1.1E-04, 1.0E-04, 1.0E-04 and 1.1E-04, for the future on-site adult resident at AOC-B, AOC-E, AOC-F, SWMU-4, SWMU-7, SWMU-9D and SWMU-12, respectively. In Attachments I1 through I7, Table 10.1.CT provides the summary of hazards and risks for the hazard and risk drivers for the hypothetical future on-site adult resident.

In Attachments I1 through I7, Table 9.2.CT provides the summary of hazards for the future on-site child resident at AOC-B, AOC-E, AOC-F, SWMU-4, SWMU-7, SWMU-9D and SWMU-12, respectively. The total HI across all media and exposure routes at each of these AOC/SWMUs was 7.5E+00, 7.7E+00, 6.8E+00, 7.0E+00, 6.3E+00, 7.4E+00, and 7.5E+00, respectively. Target organ HIs for the hypothetical future on-site child resident under CT exposure conditions at each SWMU/AOC are presented below:

Target Organ	AOC-B	AOC-E	AOC-F	SWMU-4	SWMU-7	SWMU-9D	SWMU-12
Brain	1.1	1.4	0.72	0.94	0.28	1.1	1.1
Skin	1.5	1.5	1.1	1.2	0.63	1.7	1.6
CNS	5.0	5.1	4.6	4.9	4.1	5.1	5.0

GI tract	1.0	1.1	0.66	0.8	0.28	1.0	1.0
Liver	2.2	2.4	1.7	2.0	1.6	2.1	2.1
Kidney	1.1	1.1	--	--	--	--	--
Nasal Cavity	1.1	1.2	0.69	0.8	0.32	1.1	1.0
Immune Func.	1.5	1.7	1.1	1.2	0.64	1.5	1.7
Blood	1.1	1.2	0.74	0.88	0.37	1.1	1.1

In Attachments I1 through I7, Table 10.2.CT provides the summary of hazards for the hazard drivers for the hypothetical future on-site child resident.

In Attachments I1 through I7, Table 9.3.CT provides the summary of risks for the future on-site lifetime resident at AOC-B, AOC-E, AOC-F, SWMU-4, SWMU-7, SWMU-9D and SWMU-12, respectively. The total CR across all media and exposure routes at each of these AOC/SWMUs was 6.0E-04, 6.7E-04, 6.1E-04, 6.3E-04, 6.7E-04, 6.1E-04 and 6.1E-04, respectively. In Attachments I1 through I7, Table 10.3.CT provides the summary of risks for the risk drivers for the hypothetical future on-site lifetime resident.

6.6 QUALITATIVE EVALUATION OF LEAD EXPOSURE

Lead was detected in on-site soil samples at the following concentrations:

- AOC-B: 4.5 to 61 mg/kg;
- AOC-E: 5.5 to 9.2 mg/kg;
- AOC-F: 15.2 to 110 mg/kg;
- SWMU-4: 4.9 to 75.7 mg/kg;
- SWMU-9D: 5 to 53.1 mg/kg; and
- SWMU-12: 10 to 124 mg/kg.

The maximum detected concentration of lead in soil at each AOC/SWMU was below the 400 mg/kg Soil Screening Level for lead based on the *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities* (USEPA 1994). These results indicated that no adverse health effects would be anticipated to result from construction worker, industrial worker, or adolescent trespasser exposure to lead present in on-site soils.

Lead was detected in Red Clay Creek sediment samples at concentrations ranging from 3.3 to 38.1 mg/kg. As was discussed in the Hazard Identification, the 400 mg/kg Soil Screening Level for lead based on the

Revised Interim Soil lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities (USEPA 1994) was multiplied by a factor of 10 in the screening step to account for the lack of a USEPA screening criterion specifically for sediment and based upon the assumption that exposure to sediments would occur only rarely and that prolonged exposure to lead in sediment would not be anticipated. The maximum detected concentration of lead in sediment (38.1 mg/kg) was well below the 4,000 mg/kg screening level, indicating that no adverse health effects would be anticipated from adolescent trespasser exposure or from off-site adult resident, child resident, and lifetime resident exposure to sediment.

Lead was detected in piezometer samples, ranging in concentration from 1.6 to 8.3 ug/L. The maximum concentration of lead is well below the USEPA action level for lead in drinking water (15 ug/L); therefore, no adverse health effects attributable to lead would be anticipated for the adolescent trespasser exposure or from off-site adult resident, child resident, and lifetime resident exposure to adjacent off-site surface water in Red Clay Creek (represented by piezometer data).

Lead was detected in ground water samples, ranging in concentration from 0.55 to 30 ug/L. The maximum concentration of lead is above the USEPA action level for lead in drinking water (15 ug/L); however, over a four-year sampling period during which 97 ground water samples were collected, only 3 samples contained lead at concentrations in excess of the USEPA action level for lead in drinking water. Furthermore, the average lead concentration in ground water is 3 ug/L and the UCL on the mean is 5.7 ug/L; both of which are well below the USEPA action level for lead in drinking water. Therefore, no adverse health effects attributable to lead would be anticipated from the adult on-site industrial worker, adult on-site construction worker, or from the hypothetical future on-site adult resident, child resident, and lifetime resident exposure to on-site ground water.

6.7 VAPOR INTRUSION EVALUATION

Per USEPA's request, a conservative, site-specific risk evaluation of the ground water to indoor air (vapor intrusion) pathway was performed for occupied on-site buildings that may be situated over ground water containing VOCs. Non-carcinogenic hazard and carcinogenic risk levels were calculated using the Johnson and Ettinger model (Version 3.1; 02/04) as developed by USEPA, using default model parameters and standard industrial worker exposure assumptions.

According to Hercules (personal communication, J. Hoffman, 13 October 2006), the following buildings in the Phase 2 investigation area may be occupied, either continuously or intermittently, during the working day.

- 8130 (High Pressure Laboratory);
- 8138 (AquaCat Production);
- 8143 (Semi-Plant, AquaCat Production); and
- 8501 (Powerhouse).

It should be noted that at present, Building 8130 is not occupied as it has been prepared for demolition. In order to evaluate the potential risks associated with the ground water to indoor air pathway, available ground water data from monitoring wells within a 100-foot radius of each building listed above were reviewed to identify positively detected VOCs. The Johnson and Ettinger model was then used to calculate a quantitative risk estimate for each positively-detected VOC within a 100-foot radius of each building (on a building-by-building basis). As previously stated, default model parameters and standard industrial worker exposure assumptions were used. In addition, the model incorporated the following:

- The maximum concentration of each detected VOC;
- The shallowest depth to water based on a review of soil boring logs in the vicinity of each building; and
- The default soil properties for the site-specific soil type based on a review of soil boring logs in the vicinity of each building.

A summary of the site-specific Johnson and Ettinger input parameters is presented in Table 4. The Johnson and Ettinger quantitative risk estimates for each positively-detected VOC are summarized on Table 5 (model output sheets are included in Attachment J). As shown on this table, all estimates of carcinogenic risks are within or below USEPA's acceptable risk range of 1×10^{-6} to 1×10^{-4}, and non-carcinogenic hazards are all well below 1.0. Therefore, reported concentrations of VOCs in ground water in the vicinity of potentially-occupied buildings do not pose an unacceptable hazard or risk via the vapor migration pathway. Furthermore, Hercules is planning to demolish all of the buildings included in this evaluation (personal communication, J. Hoffman, Hercules, 13 October 2006).

6.8 SUMMARY OF HUMAN HEALTH RISK ASSESSMENT RESULTS

6.8.1 Current/Future Off-Site Adolescent Trespasser

Under RME exposure conditions, the non-carcinogenic hazard calculated for the current/future off-site adolescent trespasser was equal to the target HI of unity (1) and the calculated carcinogenic risk was within the NCP acceptable risk range. These results indicated that no unacceptable non-carcinogenic hazard or carcinogenic risk would be anticipated to be posed to the off-site adolescent trespasser even under RME conditions.

6.8.2 Current/Future Off-Site Adult and Child Resident

Under RME exposure conditions, the non-carcinogenic hazard calculated for the current/future off-site adult resident was below the target HI of unity (1) and the calculated carcinogenic risk was within the NCP acceptable risk range. These results indicated that no unacceptable non-carcinogenic hazard or carcinogenic risk would be anticipated to be posed to the current/future off-site adult resident even under RME conditions.

Under RME exposure conditions, the non-carcinogenic hazard calculated for the current/future off-site child resident was above the target HI of unity (1). However, under CT exposure conditions, the non-carcinogenic hazard was below target HI of unity (1). These results suggest an increased likelihood of adverse non-carcinogenic health effects associated with contact with surface water in Red Clay Creek (as represented by piezometer data). However, piezometer data are not reflective of actual conditions in Red Clay Creek surface water, resulting in an over-estimation of potential hazard. Further discussion of surface water in Red Clay Creek is presented in Section 8.4.

Under RME exposure conditions, the total carcinogenic risk calculated for the current/future off-site lifetime resident was above the NCP acceptable risk range. However, surface water drivers were within the NCP acceptable risk range, and under CT exposure conditions, carcinogenic risk was within the NCP acceptable risk range. As previously mentioned, these results suggest an increased likelihood of carcinogenic health effects associated with contact with surface water in Red Clay Creek (as represented by piezometer data). However, piezometer data are not reflective of actual conditions in Red Clay Creek surface water, resulting in an over-estimation of potential risk. Further discussion of surface water in Red Clay Creek is presented in Section 8.4.

6.8.3 Current On-Site Industrial Worker

Under RME exposure conditions, the non-carcinogenic hazard calculated for the current on-site industrial worker was below the target HI of unity (1) and the calculated carcinogenic risk was within the NCP acceptable risk range at all of the SWMU/AOCs, except for carcinogenic risk at SWMU-7. These results indicated that no unacceptable non-carcinogenic hazard or carcinogenic risk would be anticipated to be posed to the on-site industrial worker even under RME conditions at any of the SWMU/AOCs except SWMU-7. Since the original preparation of this risk assessment, the soil location within SWMU -7 that contained the maximum concentration of TCDD was excavated as part of remedial activities at SWMU 8/9C (location SS-7). Removal of this data point from the TCDD dataset results in a significantly lower RME concentration (UCL reduced from 3.69E-03 mg/kg to 2.33E-04 mg/kg). Subsequently, carcinogenic risk at SWMU-7 is an order of magnitude lower under current conditions than what is presented herein, and falls within the NCP acceptable risk range. The re-calculation of carcinogenic risk at SWMU-7 soil is presented as Attachment M for informational purposes.

Furthermore, with respect to RME conditions at SWMU-7, SWMU-7 is less than one-half an acre in size, and therefore it is an unlikely scenario for a current or future industrial worker to spend all of their outdoor time in this single, small location.

6.8.4 Future On-Site Industrial Worker

Under RME exposure conditions, the non-carcinogenic hazard calculated for the future on-site industrial worker was above the target HI of unity (1) and the calculated carcinogenic risk was above the NCP acceptable risk range at all of the SWMU/AOCs, based on use of on-site ground water. These results suggest an increased chance of adverse health effects for this receptor population. However, the risks identified are driven by the consumption and exposure to on-site ground water; an unlikely exposure scenario which is not a current, or reasonable potential future, condition. On-site production wells were decommissioned and abandoned in March 2008.

Without the consideration of ground water exposure, the results are the same as for the current on-site industrial worker presented in the previous section. No unacceptable non-carcinogenic hazard or carcinogenic risk would be anticipated to be posed to the on-site industrial worker even under RME conditions at any of the SWMU/AOCs except SWMU-7. As described above, because of remedial activities at SWMU 8/9C, carcinogenic risk at SWMU-7 is an order of magnitude lower under current conditions than what is presented herein, and falls within the NCP acceptable risk range (Attachment M). Furthermore, with respect to RME conditions at SWMU-7, SWMU-7 is less than one-half an acre in size, and therefore it is an unlikely scenario for a current or future industrial worker to spend all of their outdoor time in this single, small location.

6.8.5 *Current/Future On-Site Construction Worker*

Under RME exposure conditions, the calculated carcinogenic risk for the current/future on-site construction worker was within the NCP acceptable risk range at all of the SWMU/AOCs; although, the non-carcinogenic hazard calculated was above the target HI of unity (1). These results suggest an increased likelihood of adverse non-carcinogenic health effects for this receptor population. The elevated hazard indices for the construction worker are driven by incidental ground water exposure. It should be noted that under CT exposure conditions, the non-carcinogenic hazard calculated for the current/future on-site construction worker was below the target HI of unity (1).

6.8.6 *Hypothetical Future On-Site Resident*

Under RME exposure conditions, the non-carcinogenic hazard calculated for the hypothetical future on-site adult, child, and lifetime resident was above the target HI of unity (1) and the calculated carcinogenic risk was above the NCP acceptable risk range at all of the SWMU/AOCs . These results indicated that unacceptable non-carcinogenic hazard and carcinogenic risk would be anticipated to be posed to the hypothetical future on-site adult, child, and lifetime resident under RME conditions.

With respect to the hypothetical future on-site adult resident, under CT exposure conditions, the calculated carcinogenic risk was within the NCP acceptable risk range at all of the SWMU/AOCs. The non-carcinogenic hazard under CT exposure conditions was above the target HI of unity (1), indicating unacceptable non-carcinogenic hazard would be anticipated to be posed to the hypothetical future on-site adult. The non-carcinogenic hazard is driven primarily by the ingestion of on-site ground water and the dermal contact with on-site ground water.

With respect to the hypothetical future on-site child resident, under CT exposure conditions, the non-carcinogenic hazard was above the target HI of unity (1) at all of the SWMU/AOCs. These results indicated that unacceptable non-carcinogenic hazard would be anticipated to be posed to the hypothetical future on-site child. The non-carcinogenic hazard is driven primarily by the ingestion of and dermal contact with on-site ground water; however, non-carcinogenic hazards calculated for soil at several of the SWMU/AOCs were also above the target HI of unity (1).

With respect to the hypothetical future on-site lifetime resident, under CT exposure conditions, the calculated carcinogenic risk was above the NCP acceptable risk range at all of the SWMU/AOCs. These results indicated that unacceptable carcinogenic risk would be anticipated to be posed to the hypothetical future on-site lifetime resident. Carcinogenic risk is driven primarily by exposure to on-site ground water (ingestion, inhalation and dermal contact) and soil at SMWU-7 only.

6.9 HUMAN HEALTH RISK ASSESSMENT RECOMMENDATIONS

The results of the risk assessment described in this HHRA indicate that the hypothetical future residential use of the Hercules site may be expected to result in unacceptable levels of non-carcinogenic hazard and unacceptable levels of carcinogenic risk to the hypothetical future adult resident, child resident, and lifetime resident populations evaluated quantitatively in this risk assessment. Exposure to COPCs currently present in on-site ground water was determined to be the driver for both the hazard and risk for these hypothetical future on-site resident receptors. Elevated hazards and/or risks may also be anticipated to result from exposure to on-site soil at AOC-B, AOC-E, SWMU-7, SWMU-9D and SWMU-12 under RME and/or CT exposure conditions for the hypothetical future adult resident, child resident, and/or lifetime resident. It should be noted that actual surface water concentrations in Red Clay Creek are expected to be much lower than the concentrations detected in the piezometers used to represent surface water in the risk calculations. This is further discussed in the Uncertainty section of this report (Section 8.4).

Although future residential development of the site is highly unlikely given that the site is an active industrial facility and located in a flood plain, ERM recommends that appropriate institutional land use restrictions be implemented to prevent future redevelopment of the site for residential use. ERM also recommends that appropriate institutional controls be undertaken to prevent future use of ground water for potable purposes at the site. By enforcing these institutional controls, contact with the impacted on-site media would be prevented, thereby resulting in incomplete residential exposure pathways. This would, by definition, result in *de minimis* hazard and risk for those residential receptors.

Under RME exposure conditions, hazard indices calculated for current/future construction workers suggested an increased likelihood of adverse non-carcinogenic health effects for this receptor population based on incidental contact with ground water. Typically, incidental contact with ground water by construction workers engaged in excavation is deemed to not be of concern because water entering an excavation would, by necessity, be removed by de-watering in order for the construction activities to proceed. The potential for construction worker direct contact exposure to groundwater is *de minimis* compared to the potential for direct contact soil exposures. However, ERM recommends that appropriate institutional controls be undertaken to reduce and/or prevent this type of exposure.

Potential adverse health effects were identified for the current/future industrial worker based on dioxins in soil at SWMU-7 and ground water (as a potable water source). There is no current source of potable ground water because Hercules decommissioned and abandoned on-site production wells in March 2008. In addition, because of remedial activities at SWMU 8/9C, carcinogenic risk at SWMU-7 is an order of magnitude lower under current conditions than what is presented herein, and falls within the NCP acceptable risk range (Attachment M). Furthermore, SWMU-7 is less than one-half an acre in size, and therefore it is an unlikely scenario for a current or future industrial worker to spend all of their outdoor time in this single, small location. Based on these considerations, potential risk from soil at SWMU-7 is considered *de minimis*. As discussed above, ERM recommends that appropriate institutional controls be undertaken to prevent future use of ground water for potable purposes at the site, thereby eliminating this exposure pathway.

7.0 SOIL SCREENING LEVEL EVALUATION FOR POTENTIAL MIGRATION TO GROUND WATER

All on-site soil data were compared to soil to ground water transfer values, or Soil Screening Levels (SSLs). The first step in the analysis was the calculation of a site-specific dilution attenuation factor (DAF). This value was calculated based on site-specific aquifer characteristics such as hydraulic conductivity, hydraulic gradient, and aquifer thickness. These data were obtained from slug tests conducted during the Phase 2 RFI. Table 6 presents the DAF input parameters and calculation results for each of the soil SWMU/AOCs.

Based on site-specific DAFs ranging from 1.43 to 10.21, on-site soil data were compared to generic Region 3 SSLs at DAF 1 (RBC Table 6 April 2007) for each AOC/SWMU. Positively-detected constituents in soil from the 0 – 10 foot and >10 foot intervals were screened separately and are presented in Attachment K, as follows:

- AOC B: Table K1 (0 – 10 feet) and Table K1a (>10 feet)
- AOC E: Table K2 (0 – 10 feet) and Table K2a (>10 feet)
- AOC F: Table K3 (0 – 10 feet)
- SWMU 4: Table K4 (0 – 10 feet) and Table K4a (>10 feet)
- SWMU 7: Table K5 (0 – 10 feet)
- SWMU 9D: Table K6 (0 – 10 feet) and Table K6a (>10 feet)
- SWMU 12: Table K7 (0 – 10 feet) and Table K7a (>10 feet)

As summarized in the SSL screening tables, there are several exceedances of Region 3 generic SSLs at DAF 1.

Site-specific SSLs were calculated for those constituents that exceeded Region 3 generic SSLs at DAF 1 at each SWMU/AOC. Results of these calculations are presented in report Tables 7 through 13 for AOC-B, AOC-E, AOC-F, SWMU-4, SWMU-7, SWMU-9D and SWMU-12, respectively. As summarized in the site-specific SSL calculation tables, there are several exceedances of site-specific SSLs compared to maximum concentrations of constituents in soil at each SWMU/AOC.

8.0 *UNCERTAINTY*

The carcinogenic risk and non-carcinogenic hazard estimates presented in this HHRA are not intended to be calculations of absolute risk or hazard to individuals who may use the site currently or in the future. Uncertainties in underlying data prevent exact determination of risk to receptor populations. The goal of the HHRA was to provide reasonable, conservative risk estimates to guide decision-making. Using standardized methodology guidelines, in particular, *RAGS Part D* (USEPA 2001) and standardized default exposure factors provided in USEPA (1997a) risk assessments for Superfund sites, provides a basis for evaluating whether remediation should be considered.

USEPA (1991b) states that, "Where the cumulative carcinogenic site risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10^{-4}, and the non-carcinogenic hazard quotient is less than 1, action generally is not warranted unless there are adverse environmental impacts." Moreover, USEPA guidance (USEPA 1989, 2001) acknowledges that uncertainty in a risk assessment can cause differences in the numerical results of more than an order of magnitude. Therefore, it is important to document and discuss the types of uncertainties that may affect the risk estimates calculated in the previous section.

Risk is broadly a function of exposure and toxicity. Therefore, uncertainties in characterizing either of these cause inaccuracy in risk estimates. Specific sources of uncertainty can be divided into two groups: methodological and site-specific. These types of uncertainties are described in the following subsections. Their effect on final risk estimates is discussed, where possible.

8.1 *GENERAL METHODOLOGICAL UNCERTAINTIES*

8.1.1 *Site Characterization*

It is sometimes impossible to completely characterize heterogeneous environmental media from a statistical standpoint. Soil constituent concentrations may vary by orders of magnitude over intervals of an inch or less; air constituent concentrations vary greatly over space and time. In some cases, only a few samples are available to evaluate a particular medium or potential source area. Risk estimates based on a limited sample database may not be representative of actual contamination, as is the case for this site. Samples were concentrated in those areas suspected to have come in contact with site-related constituents and, therefore, are considered a conservative representation of the impacts due to former site activities.

8.1.2 *Toxicological Information*

Toxicity data used in human health risk assessments can be limited. Much of the data used to generate health criteria are derived from animal studies. Uncertainties result given that:

- both endpoints of toxicity (effect or target organ) and the doses at which effects are observed are extrapolated from animals to humans;
- results of short-term exposure studies are used to predict the effects of long-term exposures;
- results of studies using high doses are used to predict effects from exposures to low doses usually expected at hazardous waste sites; and
- effects exhibited by homogeneous populations of animals (or humans) are used to predict effects in heterogeneous populations with variable sensitivities (e.g., the young, elderly, or infirm).

In addition, thorough toxicity data are not available for all constituents detected at many sites. Often, the toxicity value for the most potent constituent in a group is used as a surrogate for structurally similar compounds. This may result in the overestimation of risk.

USEPA and other regulatory agencies attempt to account for these sources of uncertainty by including uncertainty factors in the determination of health criteria such as RfDs. In addition, the level of confidence in RfDs for non-carcinogenic effects and the weight of evidence for carcinogenic effects are specified for each constituent. These qualifiers have been discussed in the dose-response section of this HHRA (Section 5.1).

8.1.3 *Exposure Assumptions*

Evaluating exposure to environmental constituents requires a number of different inputs and assumptions. These include the types of exposed populations, including their ages and health conditions; average lifespans; activity patterns such as time spent indoors versus outdoors, time spent at different locations; time spent working or residing in the area of the site; contact rates for contaminated media; skin surface area for dermal contact; and absorption rates via the skin and digestive tract. There are significant uncertainties regarding the extent to which a constituent is absorbed from soil through the skin.

Current USEPA guidance for conducting risk assessments at Superfund sites recommends values to be used for many of these parameters. This serves to reduce unwarranted variability in exposure assumptions used to perform baseline risk assessments across different sites.

Because values specified in guidance documents are often conservative, upper-bound figures, they would rarely lead to underestimating risks. Site-specific exposure parameters should be used over standard default exposure parameters when they are known to prevent masking of site-specific variations.

Baseline risk assessments also estimate current and future exposure scenarios based on constituent concentrations detected at the site during the site investigation. In general, no attenuation or degradation of constituents over space or time is assumed. This also typically results in a conservative estimate of risk, especially for organic constituents that are typically subjected to natural degradation processes such as biodegradation, volatilization, and oxidation/reduction. In some cases, though, natural degradation processes do result in daughter products more toxic than the parent compound which could result in greater future human health risk.

8.1.4 Dermal Contact Pathway

The use of adjusted toxicity values for the assessment of dermal risks is another source of uncertainty in the risk assessment. Adjusted oral toxicity values were generated based on USEPA recommended oral absorption factors. Oral absorption factors are based primarily on animal studies that are not always the same species associated with the toxicity study.

Methods used to evaluate dermal exposure, in many cases, significantly contribute to overestimates of risk. The approach used to assess potential risks associated with dermal exposure to soil followed USEPA guidance (USEPA 2004). However, it must be emphasized that this approach is very conservative and may significantly overestimate potential risks. This overestimation may be particularly significant for inorganic constituents which, in general, are poorly absorbed across the skin membrane. Sources of this conservatism include the following:

- Consistent with USEPA guidance (2004), oral slope factors and reference doses provided the basis for evaluating potential toxicity from the dermal route of exposure. These toxicity indices were adjusted to reflect absorbed rather than administered doses, in order that the indices would be consistent with the calculated intakes (which were also calculated as absorbed doses).

- Dermal absorption values found in USEPA guidance and in the literature were generally developed for pure, unweathered compounds applied directly to the skin. These values are likely to significantly overestimate the dermal absorption of residual soil constituents, which tend to be sorbed to soil particles or otherwise bound in the soil matrix, and, hence, are absorbed much less readily across the skin membrane. Because only limited information is available regarding the oral absorption of various constituents, the adjustments used in this calculation were based on the conservative extrapolation of oral absorption values from similar or related constituents. That is, the absorption value used to adjust each toxicity index was generally based on the lowest value available for a similar constituent.
- For dermal exposure to soil, exposure factors such as the exposed skin surface area and soil adherence are generally not well defined (USEPA 2004). Although the recommended dermal absorption factors are based upon potential absorption from soil and not dermal absorption of the pure compound, USEPA guidance for these parameters suggests the use of upper bound values to ensure that potential risks are not underestimated. However, the collective result of using upper bound estimates for these parameters may be the significant overestimation of potential risks related to the dermal route of exposure.

8.2 RISK CHARACTERIZATION

Constituent-specific risks are generally assumed to be additive. This oversimplifies the fact that some constituents are thought to act synergistically (1 + 1 > 3) while others act antagonistically (1 + 1 < 3). The overall effect of these mechanisms on multi-constituent, multi-media risk estimates is difficult to determine but the effects are usually assumed to balance.

8.3 SITE-SPECIFIC UNCERTAINTIES

Potential site-specific sources of uncertainty for the site include the following:

- degree of characterization of contamination in all media;

- availability of toxicity data for certain COPCs;
- future land use and status of local public water supplies; and
- exposure parameter values.

Although future residential development of the site is highly unlikely given that the site is an active industrial facility and located in a flood plain, USEPA Region 3 requested that Hercules evaluate potential hazards and risk posed to hypothetical future on-site residents. Calculating quantitative hazard and risk estimates in this risk estimate was, in itself, highly conservative since there is currently no planned change in future land use at the site from industrial to residential. Significant zoning changes would be necessary in order for future residential development of the property to even be considered. By instituting appropriate land use restrictions and ground water use restrictions, unacceptable non-carcinogenic hazard and unacceptable carcinogenic risk to future users of the property can be prevented.

It should also be noted that inhalation hazard and risk associated with exposure to sediment in Red Clay Creek was quantitatively evaluated in the HHRA even though sediment in Red Clay Creek is not known to become exposed, even during severe drought conditions. To assume there are situations where sediment in Red Clay Creek may become airborne as particulate matter may result in significant overestimation of potential risks related sediment exposure.

Furthermore, dermal contact and incidental ingestion hazard and risk associated with exposure of on-site construction workers to ground water was quantitatively evaluated in the HHRA. This was a conservative assumption to capture potential hazard and risk from contact by an on-site construction worker to ground water "pooling" in an excavation. Although the average depth to ground water on-site is shallow (approximately four feet), typical footers for building construction do not exceed three feet, and would also not typically be placed in soils within the ground water table. Therefore, the evaluation of this pathway may result in significant overestimation of potential risks for this exposure pathway.

Exposure parameters for the HHRA were obtained from USEPA guidance or peer-reviewed literature, with input from USEPA Region 3. Most of these assumptions are considered average or reasonable maximum exposure estimates that would not likely underestimate exposure. While there are situations where parameters may produce underestimates, it is highly unlikely that the cumulative effect of all exposure parameter estimates will lead to underestimates of risk.

8.4 DATA-RELATED UNCERTAINTIES

Risk estimates are intended to be conservative best estimates of actual or potential risks associated with site COPCs. However, if the quality of the data set is poor or uncertain, confidence in these risk estimates is reduced.

Since no surface water samples were collected from Red Clay Creek during the Phase 2 RFI, concentrations of constituents in on-site piezometers were used as surrogate data to evaluate surface water exposures. This approach is highly conservative given that a significant amount of dilution is expected to occur upon the discharge of ground water (as represented by piezometer data) to Red Clay Creek. Thus, concentrations of constituents in surface water are expected to be several orders of magnitude lower than what is measured in piezometers.

To investigate this further, Roux performed dilution factor calculations for constituents in ground water (piezometers) based on the ratio of ground water flow to surface water flow in Red Clay Creek. Dilution factors were constituent-specific based upon the length along Red Clay Creek that a compound was detected. Although no non-carcinogenic hazards or cancer risks were identified in piezometer water (as a stand-alone medium) to any receptor population under CT exposure conditions, when the most conservative dilution factor was applied to the concentration of COPCs in piezometers (highest ground water to surface water flow ratio), no non-carcinogenic hazards or cancer risks were identified for Red Clay Creek surface water exposure even under RME exposure conditions. Risk calculation tables to support this conclusion are presented in Attachment L.

9.0 REFERENCES

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TABLES

Table 1
Summary of Attachments to the HHRA
Hercules Research Center
Wilmington, Delaware

Attachment ID	Scenario Timeframe	Receptor Population	Exposure Medium	Comments
A	Current/Future	Off-Site Adolescent Trespasser	Surface Water, Sediment (Red Clay Creek)	Represents the only exposure medium for this receptor population
B	Current/Future	Off-Site Resident	Surface Water, Sediment (Red Clay Creek)	Represents the only exposure medium for this receptor population
C	Future	On-Site Resident	Surface Water, Sediment (Red Clay Creek)	Not a stand alone exposure medium, therefore, Attachment C does not include Tables 9 and 10; results are added to each AOC/SWMU-specific soil Tables 9 and 10 for each unique receptor population
D	Future	On-Site Industrial Worker/On-Site Resident	Ground Water	Not a stand alone exposure medium, therefore, Attachment D does not include Tables 9 and 10; results are added to each AOC/SWMU-specific soil Tables 9 and 10 for each unique receptor population
E	Current/Future	On-Site Construction Worker	Ground Water	Not a stand alone exposure medium, therefore, Attachment E does not include Tables 9 and 10; results are added to each AOC/SWMU-specific soil Tables 9 and 10 for each unique receptor population
F1	Current	On-Site Industrial Worker	Soil – AOC B	Represents the only exposure medium for this receptor population
F2	Current	On-Site Industrial Worker	Soil – AOC E	Represents the only exposure medium for this receptor population
F3	Current	On-Site Industrial Worker	Soil – AOC F	Represents the only exposure medium for this receptor population
F4	Current	On-Site Industrial Worker	Soil – SWMU 4	Represents the only exposure medium for this receptor population
F5	Current	On-Site Industrial Worker	Soil – SWMU 7	Represents the only exposure medium for this receptor population
F6	Current	On-Site Industrial Worker	Soil – SWMU 9D	Represents the only exposure medium for this receptor population
F7	Current	On-Site Industrial Worker	Soil – SWMU 12	Represents the only exposure medium for this receptor population
G1	Future	On-Site Industrial Worker	Soil – AOC B, Ground Water	Tables 1 - 8 are identical to Attachment F1 Tables 1 - 8, Tables 9 and 10 include exposure to ground water (from Attachment D)
G2	Future	On-Site Industrial Worker	Soil – AOC E, Ground Water	Tables 1 - 8 are identical to Attachment F1 Tables 1 - 8, Tables 9 and 10 include exposure to ground water (from Attachment D)
G3	Future	On-Site Industrial Worker	Soil – AOC F, Ground Water	Tables 1 - 8 are identical to Attachment F3 Tables 1 - 8, Tables 9 and 10 include exposure to ground water (from Attachment D)
G4	Future	On-Site Industrial Worker	Soil – SWMU 4, Ground Water	Tables 1 - 8 are identical to Attachment F4 Tables 1 - 8, Tables 9 and 10 include exposure to ground water (from Attachment D)
G5	Future	On-Site Industrial Worker	Soil – SWMU 7, Ground Water	Tables 1 - 8 are identical to Attachment F5 Tables 1 - 8, Tables 9 and 10 include exposure to ground water (from Attachment D)
G6	Future	On-Site Industrial Worker	Soil – SWMU 9D, Ground Water	Tables 1 - 8 are identical to Attachment F6 Tables 1 - 8, Tables 9 and 10 include exposure to ground water (from Attachment D)
G7	Future	On-Site Industrial Worker	Soil – SWMU 12, Ground Water	Tables 1 - 8 are identical to Attachment F7 Tables 1 - 8, Tables 9 and 10 include exposure to ground water (from Attachment D)

Table 1
Summary of Attachments to the HHRA
Hercules Research Center
Wilmington, Delaware

Attachment ID	Scenario Timeframe	Receptor Population	Exposure Medium	Comments
H1	Current/Future	On-Site Construction Worker	Soil – AOC B, Ground Water	Tables 1 - 8 shows risk calculations for the construction worker exposed to on-site soil, Tables 9 and 10 include exposure to ground water (from Attachment E)
H2	Current/Future	On-Site Construction Worker	Soil – AOC E, Ground Water	Tables 1 - 8 shows risk calculations for the construction worker exposed to on-site soil, Tables 9 and 10 include exposure to ground water (from Attachment E)
H3	Current/Future	On-Site Construction Worker	Soil – AOC F, Ground Water	Tables 1 - 8 shows risk calculations for the construction worker exposed to on-site soil, Tables 9 and 10 include exposure to ground water (from Attachment E)
H4	Current/Future	On-Site Construction Worker	Soil – SWMU 4, Ground Water	Tables 1 - 8 shows risk calculations for the construction worker exposed to on-site soil, Tables 9 and 10 include exposure to ground water (from Attachment E)
H5	Current/Future	On-Site Construction Worker	Soil – SWMU 7, Ground Water	Tables 1 - 8 shows risk calculations for the construction worker exposed to on-site soil, Tables 9 and 10 include exposure to ground water (from Attachment E)
H6	Current/Future	On-Site Construction Worker	Soil – SWMU 9D, Ground Water	Tables 1 - 8 shows risk calculations for the construction worker exposed to on-site soil, Tables 9 and 10 include exposure to ground water (from Attachment E)
H7	Current/Future	On-Site Construction Worker	Soil – SWMU 12, Ground Water	Tables 1 - 8 shows risk calculations for the construction worker exposed to on-site soil, Tables 9 and 10 include exposure to ground water (from Attachment E)
I1	Future	On-Site Resident	Soil – AOC B, Ground Water, Surface Water, Sediment (Red Clay Creek)	Tables 1 - 8 shows risk calculations for residents exposed to on-site soil, Tables 9 and 10 include exposure to ground water (from Attachment D) and sediment/surface water (from Attachment C)
I2	Future	On-Site Resident	Soil – AOC E, Ground Water, Surface Water, Sediment (Red Clay Creek)	Tables 1 - 8 shows risk calculations for residents exposed to on-site soil, Tables 9 and 10 include exposure to ground water (from Attachment D) and sediment/surface water (from Attachment C)
I3	Future	On-Site Resident	Soil – AOC F, Ground Water, Surface Water, Sediment (Red Clay Creek)	Tables 1 - 8 shows risk calculations for residents exposed to on-site soil, Tables 9 and 10 include exposure to ground water (from Attachment D) and sediment/surface water (from Attachment C)
I4	Future	On-Site Resident	Soil – SWMU 4, Ground Water, Surface Water, Sediment (Red Clay Creek)	Tables 1 - 8 shows risk calculations for residents exposed to on-site soil, Tables 9 and 10 include exposure to ground water (from Attachment D) and sediment/surface water (from Attachment C)
I5	Future	On-Site Resident	Soil – SWMU 7, Ground Water, Surface Water, Sediment (Red Clay Creek)	Tables 1 - 8 shows risk calculations for residents exposed to on-site soil, Tables 9 and 10 include exposure to ground water (from Attachment D) and sediment/surface water (from Attachment C)
I6	Future	On-Site Resident	Soil – SWMU 9D, Ground Water, Surface Water, Sediment (Red Clay Creek)	Tables 1 - 8 shows risk calculations for residents exposed to on-site soil, Tables 9 and 10 include exposure to ground water (from Attachment D) and sediment/surface water (from Attachment C)
I7	Future	On-Site Resident	Soil – SWMU 12, Ground Water, Surface Water, Sediment (Red Clay Creek)	Tables 1 - 8 shows risk calculations for residents exposed to on-site soil, Tables 9 and 10 include exposure to ground water (from Attachment D) and sediment/surface water (from Attachment C)
J	Current/Future	On-Site Industrial Worker	Ground Water Vapor Intrusion into Indoor Air	Johnson and Ettinger (2004) vapor instrusion model output sheets for each COPC/Building.
K	N/A	N/A	Migration of Soil COPCs to Ground Water	Tables presenting the comparison of default USEPA Region 3 Soil Screening Level (SSLs) at DAF 1 to on-Site soil data at each SWMU/AOC.
L	Current/Future	Off/On-Site Resident	Surface Water (Red Clay Creek) based on piezometer data with site-specific dilution factor applied	Presents quantitative risk calculations based on modeled surface water concentrations in Red Clay Creek.

Table 1
Summary of Attachments to the HHRA
Hercules Research Center
Wilmington, Delaware

Attachment ID	Scenario Timeframe	Receptor Population	Exposure Medium	Comments
M	Current/Future	On-Site Industrial Worker	Soil – SWMU 7	Presents revised quantitative risk calculations based on current soil conditions in SWMU 7 (i.e., sample SS-7 removed from dataset because this location was excavated as part of SMU 8/9C remediation)[Note: Table 1 not included in this series since it remains unchanged from previous presentations in Att F, G, H and I]

Table 2
Dioxin/Furan Congener Data
Hercules Research Center
Wilmington, Delaware

Congener Concentration Data

Sample ID		AOC-F/SD-3		AOC-F/SD-4		AOC-F/SD-5		AOC-B/SS-6		SWMU-7/SS-4		SWMU-7/SS-5		SWMU-7/SS-6		SWMU-7/SS-7		SWMU-7/SS-9 (0.5-1)(dup avg)		SWMU-7/SS-9 (1-1.5)		SWMU-7/SS-9 (1.5-2)		SWMU-7/SS-10 (0.5-1)	
Sampling Date:	**TEF**	12/17/2003		11/18/2003		11/18/2003		11/18/2003		11/18/2003		11/18/2003		11/18/2003		11/18/2003		4/22/2010		4/22/2010		4/22/2010		4/22/2010	
Parameter																									
Dioxins (mg/kg)																									
2,3,7,8-TCDD	1	3.20E-05		1.50E-05		5.50E-07	U	6.40E-06		8.60E-05	J	1.80E-06		1.70E-04		1.70E-03	EJ	6.75E-05		3.10E-05		1.80E-05	J	1.10E-04	
1,2,3,7,8-PeCDD	1	4.40E-05		2.00E-05		1.60E-06	U	8.30E-06		1.20E-04		1.30E-06	U	1.80E-04		2.90E-03		1.04E-04	L	4.40E-05	K	2.70E-05		1.70E-04	
1,2,3,4,7,8-HxCDD	0.1	2.30E-05		9.50E-06	J	8.50E-07	U	1.70E-06	U	7.00E-05		9.00E-07	U	1.10E-04		1.00E-03		4.20E-05		1.40E-05		1.20E-05		5.40E-05	
1,2,3,6,7,8-HxCDD	0.1	4.20E-05		2.00E-05		9.00E-07	U	5.30E-06	J	1.10E-04		5.70E-06	J	1.40E-04		1.40E-03		1.10E-04		2.10E-05		1.40E-05		8.70E-05	
1,2,3,7,8,9-HxCDD	0.1	3.10E-05		1.30E-05		8.00E-07	U	4.10E-06	J	6.90E-05		1.35E-06	U	7.50E-05		9.10E-04		5.45E-05	J	1.60E-05		1.30E-05		6.80E-05	
1,2,3,4,6,7,8-HpCDD	0.01	6.50E-04		2.80E-04		7.10E-06	R	1.10E-04		1.10E-03		1.60E-04		6.90E-04		4.90E-03	EJ	9.00E-04		1.50E-04	K	1.10E-04	L	5.60E-04	
OCDD	0.0003	2.50E-02	EJ	1.20E-02	EJ	9.70E-05	K	8.30E-03	EJ	6.30E-03	EJ	8.20E-03	EJ	3.70E-03	K	3.00E-02	EJ	1.50E-02	J	6.80E-03	J	4.50E-03		1.20E-02	J
Furans (mg/kg)																									
2,3,7,8-TCDF	0.1	7.40E-05		2.40E-05		5.50E-07	U	1.40E-05		1.10E-04		6.00E-06		1.90E-04		7.30E-04	EJ	4.75E-05		1.20E-05	K	6.80E-06		4.50E-05	
1,2,3,7,8-PeCDF	0.03	1.90E-05		6.10E-06	J	1.10E-06	U	5.30E-06	J	6.60E-05		1.20E-06	U	1.20E-04		2.50E-04		2.05E-05		4.90E-06	J	1.20E-06	U	1.90E-05	
2,3,4,7,8-PeCDF	0.3	4.40E-05		1.10E-05		1.10E-06	U	8.10E-06		1.30E-04		5.20E-06	J	1.80E-04		4.00E-04		3.50E-05		7.10E-06	J	3.70E-06	J	3.10E-05	
1,2,3,4,7,8-HxCDF	0.1	3.10E-05		7.10E-06	J	5.00E-07	U	5.60E-06	J	1.20E-04		5.60E-06	J	2.00E-04		4.30E-04		5.30E-05	J	6.70E-06	J	4.70E-06	J	3.10E-05	
1,2,3,6,7,8-HxCDF	0.1	1.80E-05		2.55E-06	U	4.95E-07	U	4.40E-06	J	9.00E-05		1.10E-06	U	1.30E-04		3.10E-04		2.60E-05		5.10E-06	J	1.20E-06	U	2.30E-05	
2,3,4,6,7,8-HxCDF	0.1	1.30E-05	J	2.40E-06	U	5.50E-07	U	3.80E-06	J	8.60E-05		8.50E-07	U	1.50E-04		2.90E-04		2.50E-05		5.10E-06	J	1.10E-06	U	2.10E-05	
1,2,3,7,8,9-HxCDF	0.1	6.00E-07	U	8.00E-07	U	6.00E-07	U	1.75E-07	U	3.90E-06	J	3.65E-07	U	5.80E-06	J	1.50E-05		1.00E-06	U	1.45E-07	U	1.45E-07	U	6.00E-07	U
1,2,3,4,6,7,8-HpCDF	0.01	1.10E-04		3.50E-05		7.50E-07	U	2.00E-05		4.70E-04		2.00E-05		4.00E-04		1.70E-03		4.70E-04		4.20E-05		1.70E-05		1.80E-04	
1,2,3,4,7,8,9-HpCDF	0.01	1.00E-05	J	1.90E-06	U	8.50E-07	U	1.30E-06	U	4.50E-05		1.10E-06	U	4.50E-05		1.50E-04		2.50E-05		1.55E-06	U	6.50E-07	U	1.20E-05	
OCDF	0.0003	2.40E-04		9.00E-05		1.95E-06	U	3.80E-05		5.50E-04		5.50E-05		3.70E-04		1.40E-03		3.85E-04		4.40E-05		2.50E-05	J	1.70E-04	

Congener Concentration Data (from above) with TEFs Applied

Sample ID		AOC-F/SD-3		AOC-F/SD-4		AOC-F/SD-5		AOC-B/SS-6		SWMU-7/SS-4		SWMU-7/SS-5		SWMU-7/SS-6		SWMU-7/SS-7		SWMU-7/SS-9 (0.5-1)(dup avg)		SWMU-7/SS-9 (1-1.5)		SWMU-7/SS-9 (1.5-2)		SWMU-7/SS-10 (0.5-1)	
Sampling Date:	**TEF**	12/17/2003		11/18/2003		11/18/2003		11/18/2003		11/18/2003		11/18/2003		11/18/2003		11/18/2003		4/22/2010		4/22/2010		4/22/2010		4/22/2010	
Parameter																									
Dioxins (mg/kg)																									
2,3,7,8-TCDD	1	3.2E-05		1.5E-05		5.5E-07	U	6.4E-06		8.6E-05	J	1.8E-06		1.7E-04		1.7E-03	EJ	6.8E-05		3.1E-05		1.8E-05	J	1.1E-04	
1,2,3,7,8-PeCDD	1	4.4E-05		2.0E-05		1.6E-06	U	8.3E-06		1.2E-04		1.3E-06	U	1.8E-04		2.9E-03		1.0E-04		4.4E-05	K	2.7E-05		1.7E-04	
1,2,3,4,7,8-HxCDD	0.1	2.3E-06		9.5E-07	J	8.5E-08	U	1.7E-07	U	7.0E-06		9.0E-08	U	1.1E-05		1.0E-04		4.2E-06		1.4E-06		1.2E-06		5.4E-06	
1,2,3,6,7,8-HxCDD	0.1	4.2E-06		2.0E-06		9.0E-08	U	5.3E-07	J	1.1E-05		5.7E-07	J	1.4E-05		1.4E-04		1.1E-05		2.1E-06		1.4E-06		8.7E-06	
1,2,3,7,8,9-HxCDD	0.1	3.1E-06		1.3E-06		8.0E-08	U	4.1E-07	J	6.9E-06		1.4E-07	U	7.5E-06		9.1E-05		5.5E-06		1.6E-06		1.3E-06		6.8E-06	
1,2,3,4,6,7,8-HpCDD	0.01	6.5E-06		2.8E-06		7.1E-08	R	1.1E-06		1.1E-05		1.6E-06		6.9E-06		4.9E-05	EJ	9.0E-06		1.5E-06	K	1.1E-06		5.6E-06	
OCDD	0.0003	7.5E-06	EJ	3.6E-06	EJ	2.9E-08	K	2.5E-06	EJ	1.9E-06	EJ	2.5E-06	EJ	1.1E-06	K	9.0E-06	EJ	4.5E-06	J	2.0E-06	J	1.4E-06		3.6E-06	J
Furans (mg/kg)																									
2,3,7,8-TCDF	0.1	7.4E-06		2.4E-06		5.5E-08	U	1.4E-06		1.1E-05		6.0E-07		1.9E-05		7.3E-05	EJ	4.8E-06		1.2E-06	K	6.8E-07		4.5E-06	
1,2,3,7,8-PeCDF	0.03	5.7E-07		1.8E-07	J	3.3E-08	U	1.6E-07	J	2.0E-06		3.6E-08	U	3.6E-06		7.5E-06		6.2E-07		1.5E-07	J	3.6E-08	U	5.7E-07	
2,3,4,7,8-PeCDF	0.3	1.3E-05		3.3E-06		3.3E-07	U	2.4E-06		3.9E-05		1.6E-06	J	5.4E-05		1.2E-04		1.1E-05		2.1E-06	J	1.1E-06	J	9.3E-06	
1,2,3,4,7,8-HxCDF	0.1	3.1E-06		7.1E-07	J	5.0E-08	U	5.6E-07	J	1.2E-05		5.6E-07	J	2.0E-05		4.3E-05		5.3E-06	J	6.7E-07	J	4.7E-07	J	3.1E-06	
1,2,3,6,7,8-HxCDF	0.1	1.8E-06		2.6E-07	U	5.0E-08	U	4.4E-07	J	9.0E-06		1.1E-07	U	1.3E-05		3.1E-05		2.6E-06		5.1E-07	J	1.2E-07	U	2.3E-06	
2,3,4,6,7,8-HxCDF	0.1	1.3E-06	J	2.4E-07	U	5.5E-08	U	3.8E-07	J	8.6E-06		8.5E-08	U	1.5E-05		2.9E-05		2.5E-06		5.1E-07	J	1.1E-07	U	2.1E-06	
1,2,3,7,8,9-HxCDF	0.1	6.0E-08	U	8.0E-08	U	6.0E-08	U	1.8E-08	U	3.9E-07	J	3.7E-08	U	5.8E-07	J	1.5E-06		1.0E-07	U	1.5E-08	U	1.5E-08	U	6.0E-08	U
1,2,3,4,6,7,8-HpCDF	0.01	1.1E-06		3.5E-07		7.5E-09	U	2.0E-07		4.7E-06		2.0E-07		4.0E-06		1.7E-05		4.7E-06		4.2E-07		1.7E-07		1.8E-06	
1,2,3,4,7,8,9-HpCDF	0.01	1.0E-07	J	1.9E-08	U	8.5E-09	U	1.3E-08	U	4.5E-07		1.1E-08	U	4.5E-07		1.5E-06		2.5E-07		1.6E-08	U	6.5E-09	U	1.2E-07	
OCDF	0.0003	7.2E-08		2.7E-08		5.9E-10	U	1.1E-08		1.7E-07		1.7E-08		1.1E-07		4.2E-07		1.2E-07		1.3E-08		7.5E-09	J	5.1E-08	
TOTAL TCDD TEC		1.3E-04		5.3E-05		3.2E-06		2.5E-05		3.3E-04		1.1E-05		5.2E-04		5.31E-03		2.4E-04		8.9E-05		5.4E-05		3.3E-04	

Notes:
See page 3.

Table 2
Dioxin/Furan Congener Data
Hercules Research Center
Wilmington, Delaware

Congener Concentration Data

Sample ID		SWMU-7/SS-10 (1-1.5)		SWMU-7/SS-10 (1.5-2)		SWMU-7/SS-11 (0.5-1)		SWMU-7/SS-11 (1-1.5)		SWMU-7/SS-11 (1.5-2)		SWMU-7/SS-12 (0.5-1)		SWMU-7/SS-12 (1-1.5)		SWMU-7/SS-12 (1.5-2)		SWMU-9D/SS-6		SWMU-9D/SS-7		SWMU-12/SS-4	
Sampling Date:	**TEF**	**4/22/2010**		**4/22/2010**		**4/22/2010**		**4/22/2010**		**4/22/2010**		**4/22/2010**		**4/22/2010**		**4/22/2010**		**11/18/2003**		**11/18/2003**		**11/18/2003**	
Parameter																							
Dioxins (mg/kg)																							
2,3,7,8-TCDD	1	2.30E-05		1.10E-05		4.40E-05		1.40E-05		8.90E-06		7.50E-06		3.00E-06		4.50E-06		1.90E-05		1.10E-06	J	3.30E-07	UJ
1,2,3,7,8-PeCDD	1	3.30E-05		1.50E-05		6.90E-05		2.10E-05		1.30E-05		1.10E-05		5.00E-06	J	7.30E-06		3.40E-05		5.50E-07	U	7.00E-07	UJ
1,2,3,4,7,8-HxCDD	0.1	1.40E-05		6.30E-06	J	2.80E-05		9.30E-06		5.50E-06	J	4.90E-06	J	1.15E-06	U	1.50E-06	U	1.30E-05		3.15E-07	U	3.75E-07	UJ
1,2,3,6,7,8-HxCDD	0.1	2.40E-05		1.00E-05		5.30E-05		1.30E-05		7.70E-06		1.10E-05		4.80E-06	J	7.20E-06		4.00E-05		3.35E-07	U	8.00E-07	UJ
1,2,3,7,8,9-HxCDD	0.1	1.90E-05		1.10E-05		3.70E-05		1.30E-05		8.40E-06		1.00E-05		4.30E-06	J	6.30E-06	J	1.90E-04		3.05E-07	U	5.50E-07	UJ
1,2,3,4,6,7,8-HpCDD	0.01	2.10E-04		1.30E-04		5.60E-04		2.20E-04		1.20E-04		2.00E-04		1.40E-04		1.60E-04		6.20E-05		8.50E-06		5.40E-05	J
OCDD	0.0003	6.80E-03	J	5.40E-03		1.50E-02	J	1.10E-02	J	5.20E-03		1.20E-02	J	8.80E-03	J	8.50E-03	J	8.80E-03	EJ	8.70E-04	K	4.90E-03	J
Furans (mg/kg)																							
2,3,7,8-TCDF	0.1	1.00E-05		6.60E-06		2.10E-05		5.50E-06		3.30E-06		5.10E-06		1.70E-06		2.40E-06		1.60E-05		7.90E-07	J	2.80E-07	UJ
1,2,3,7,8-PeCDF	0.03	4.60E-06	J	1.45E-07	U	8.80E-06		1.10E-06	U	6.00E-07	U	1.10E-06	U	3.30E-07	U	6.00E-07	U	4.90E-06	J	2.55E-07	U	4.20E-07	UJ
2,3,4,7,8-PeCDF	0.3	6.70E-06	J	4.60E-06	J	1.30E-05		3.60E-06	J	9.00E-07	U	1.60E-06	U	4.80E-07	U	8.00E-07	U	2.10E-05		2.45E-07	U	4.20E-07	UJ
1,2,3,4,7,8-HxCDF	0.1	9.00E-06		6.00E-06	J	2.00E-05		5.30E-06	J	3.80E-06	J	5.30E-06	J	1.25E-06	U	1.70E-06	U	8.90E-06		2.75E-07	U	7.50E-07	UJ
1,2,3,6,7,8-HxCDF	0.1	5.00E-06	J	3.60E-06	J	1.20E-05		1.70E-06	U	9.50E-07	U	1.25E-06	U	5.50E-07	U	8.50E-07	U	6.70E-06	J	1.95E-07	U	3.05E-07	UJ
2,3,4,6,7,8-HxCDF	0.1	4.10E-06	J	1.70E-06	U	8.50E-06		1.55E-06	U	9.00E-07	U	1.15E-06	U	7.00E-07	U	9.00E-07	U	6.90E-06	J	2.15E-07	U	3.50E-07	UJ
1,2,3,7,8,9-HxCDF	0.1	1.95E-07	U	1.45E-07	U	4.05E-07	U	1.25E-07	U	1.05E-07	U	9.50E-08	U	1.05E-07	U	2.60E-07	U	2.20E-07	U	2.40E-07	U	3.80E-07	UJ
1,2,3,4,6,7,8-HpCDF	0.01	5.70E-05		2.10E-05		1.30E-04		2.60E-05		1.40E-05		2.80E-05		1.10E-05		1.40E-05		8.50E-05		4.50E-07	U	6.90E-06	J
1,2,3,4,7,8,9-HpCDF	0.01	3.50E-06	J	1.15E-06	U	7.20E-06	J	9.50E-07	U	6.50E-07	U	1.10E-06	U	3.05E-07	U	3.50E-07	U	4.40E-06	J	3.20E-07	U	3.65E-07	UJ
OCDF	0.0003	5.00E-05		2.90E-05		1.30E-04		2.50E-05		1.70E-05		3.10E-05		1.40E-05		2.00E-05		1.60E-04		1.50E-06	U	2.60E-05	J

Congener Concentration Data (from above) with TEFs Applied

Sample ID		SWMU-7/SS-10 (1-1.5)		SWMU-7/SS-10 (1.5-2)		SWMU-7/SS-11 (0.5-1)		SWMU-7/SS-11 (1-1.5)		SWMU-7/SS-11 (1.5-2)		SWMU-7/SS-12 (0.5-1)		SWMU-7/SS-12 (1-1.5)		SWMU-7/SS-12 (1.5-2)		SWMU-9D/SS-6		SWMU-9D/SS-7		SWMU-12/SS-4	
Sampling Date:	**TEF**	**4/22/2010**		**4/22/2010**		**4/22/2010**		**4/22/2010**		**4/22/2010**		**4/22/2010**		**4/22/2010**		**4/22/2010**		**11/18/2003**		**11/18/2003**		**11/18/2003**	
Parameter																							
Dioxins (mg/kg)																							
2,3,7,8-TCDD	1	2.3E-05		1.1E-05		4.4E-05		1.4E-05		8.9E-06		7.5E-06		3.0E-06		4.5E-06		1.9E-05		1.1E-06	J	3.3E-07	UJ
1,2,3,7,8-PeCDD	1	3.3E-05		1.5E-05		6.9E-05		2.1E-05		1.3E-05		1.1E-05		5.0E-06	J	7.3E-06		3.4E-05		5.5E-07	U	7.0E-07	UJ
1,2,3,4,7,8-HxCDD	0.1	1.4E-06		6.3E-07	J	2.8E-06		9.3E-07		5.5E-07	J	4.9E-07	J	1.2E-07	U	1.5E-07	U	1.3E-06		3.2E-08	U	3.8E-08	UJ
1,2,3,6,7,8-HxCDD	0.1	2.4E-06		1.0E-06		5.3E-06		1.3E-06		7.7E-07		1.1E-06		4.8E-07	J	7.2E-07		4.0E-06		3.4E-08	U	8.0E-08	UJ
1,2,3,7,8,9-HxCDD	0.1	1.9E-06		1.1E-06		3.7E-06		1.3E-06		8.4E-07		1.0E-06		4.3E-07	J	6.3E-07	J	1.9E-05		3.1E-08	U	5.5E-08	UJ
1,2,3,4,6,7,8-HpCDD	0.01	2.1E-06		1.3E-06		5.6E-06		2.2E-06		1.2E-06		2.0E-06		1.4E-06		1.6E-06		6.2E-07		8.5E-08		5.4E-07	J
OCDD	0.0003	2.0E-06	J	1.6E-06		4.5E-06	J	3.3E-06	J	1.6E-06		3.6E-06	J	2.6E-06	J	2.6E-06	J	2.6E-06	EJ	2.6E-07	K	1.5E-06	J
Furans (mg/kg)																							
2,3,7,8-TCDF	0.1	1.0E-06		6.6E-07		2.1E-06		5.5E-07		3.3E-07		5.1E-07		1.7E-07		2.4E-07		1.6E-06		7.9E-08	J	2.8E-08	UJ
1,2,3,7,8-PeCDF	0.03	1.4E-07	J	4.4E-09	U	2.6E-07		3.3E-08	U	1.8E-08	U	3.3E-08	U	9.9E-09	U	1.8E-08	U	1.5E-07	J	7.7E-09	U	1.3E-08	UJ
2,3,4,7,8-PeCDF	0.3	2.0E-06	J	1.4E-06	J	3.9E-06		1.1E-06	J	2.7E-07	U	4.8E-07	U	1.4E-07	U	2.4E-07	U	6.3E-06		7.4E-08	U	1.3E-07	UJ
1,2,3,4,7,8-HxCDF	0.1	9.0E-07		6.0E-07	J	2.0E-06		5.3E-07	J	3.8E-07	J	5.3E-07	J	1.3E-07	U	1.7E-07	U	8.9E-07		2.8E-08	U	7.5E-08	UJ
1,2,3,6,7,8-HxCDF	0.1	5.0E-07	J	3.6E-07	J	1.2E-06		1.7E-07	U	9.5E-08	U	1.3E-07	U	5.5E-08	U	8.5E-08	U	6.7E-07	J	2.0E-08	U	3.1E-08	UJ
2,3,4,6,7,8-HxCDF	0.1	4.1E-07	J	1.7E-07	U	8.5E-07		1.6E-07	U	9.0E-08	U	1.2E-07	U	7.0E-08	U	9.0E-08	U	6.9E-07	J	2.2E-08	U	3.5E-08	UJ
1,2,3,7,8,9-HxCDF	0.1	2.0E-08	U	1.5E-08	U	4.1E-08	U	1.3E-08	U	1.1E-08	U	9.5E-09	U	1.1E-08	U	2.6E-08	U	2.2E-08	U	2.4E-08	U	3.8E-08	UJ
1,2,3,4,6,7,8-HpCDF	0.01	5.7E-07		2.1E-07		1.3E-06		2.6E-07		1.4E-07		2.8E-07		1.1E-07		1.4E-07		8.5E-07		4.5E-09	U	6.9E-08	J
1,2,3,4,7,8,9-HpCDF	0.01	3.5E-08	J	1.2E-08	U	7.2E-08	J	9.5E-09	U	6.5E-09	U	1.1E-08	U	3.1E-09	U	3.5E-09	U	4.4E-08	J	3.2E-09	U	3.7E-09	UJ
OCDF	0.0003	1.5E-08		8.7E-09		3.9E-08		7.5E-09		5.1E-09		9.3E-09		4.2E-09		6.0E-09		4.8E-08		4.5E-10	U	7.8E-09	J
TOTAL TCDD TEC		7.1E-05		3.5E-05		1.5E-04		4.7E-05		2.8E-05		2.9E-05		1.4E-05		1.8E-05		9.2E-05		2.4E-06		3.6E-06	

Notes:
See page 3.

Table 2
Dioxin/Furan Congener Data
Hercules Research Center
Wilmington, Delaware

Congener Concentration Data

Sample ID		SWMU-12/SS-3	
Sampling Date:	TEF	11/18/2003	
Parameter			
Dioxins (mg/kg)			
2,3,7,8-TCDD	1	2.10E-05	
1,2,3,7,8-PeCDD	1	2.10E-05	
1,2,3,4,7,8-HxCDD	0.1	2.10E-05	
1,2,3,6,7,8-HxCDD	0.1	2.10E-05	
1,2,3,7,8,9-HxCDD	0.1	2.10E-05	
1,2,3,4,6,7,8-HpCDD	0.01	2.10E-05	
OCDD	0.0003	2.10E-05	EJ
Furans (mg/kg)			
2,3,7,8-TCDF	0.1	2.10E-05	
1,2,3,7,8-PeCDF	0.03	2.10E-05	J
2,3,4,7,8-PeCDF	0.3	2.10E-05	
1,2,3,4,7,8-HxCDF	0.1	2.10E-05	
1,2,3,6,7,8-HxCDF	0.1	2.10E-05	J
2,3,4,6,7,8-HxCDF	0.1	2.10E-05	J
1,2,3,7,8,9-HxCDF	0.1	2.10E-05	U
1,2,3,4,6,7,8-HpCDF	0.01	2.10E-05	
1,2,3,4,7,8,9-HpCDF	0.01	2.10E-05	J
OCDF	0.0003	2.10E-05	

Congener Concentration Data (from above) with TEFs Applied

Sample ID		SWMU-12/SS-3	
Sampling Date:	TEF	11/18/2003	
Parameter			
Dioxins (mg/kg)			
2,3,7,8-TCDD	1	2.1E-05	
1,2,3,7,8-PeCDD	1	2.1E-05	
1,2,3,4,7,8-HxCDD	0.1	2.1E-06	
1,2,3,6,7,8-HxCDD	0.1	2.1E-06	
1,2,3,7,8,9-HxCDD	0.1	2.1E-06	
1,2,3,4,6,7,8-HpCDD	0.01	2.1E-07	
OCDD	0.0003	6.3E-09	EJ
Furans (mg/kg)			
2,3,7,8-TCDF	0.1	2.1E-06	
1,2,3,7,8-PeCDF	0.03	6.3E-07	J
2,3,4,7,8-PeCDF	0.3	6.3E-06	
1,2,3,4,7,8-HxCDF	0.1	2.1E-06	
1,2,3,6,7,8-HxCDF	0.1	2.1E-06	J
2,3,4,6,7,8-HxCDF	0.1	2.1E-06	J
1,2,3,7,8,9-HxCDF	0.1	2.1E-06	U
1,2,3,4,6,7,8-HpCDF	0.01	2.1E-07	
1,2,3,4,7,8,9-HpCDF	0.01	2.1E-07	J
OCDF	0.0003	6.3E-09	
TOTAL TCDD TEC		6.6E-05	

Table Notes:
Only congeners for which TEFs area available are shown.
TEF source: World Health Organization (2005), as reported in USEPA Regional Screening Levels User's Guide (2010).

U = Not detected; Value represents one-half the method detection limit.
J = Estimated concentration. Result is less than the reporting limit.
E = Estimated concentration. Result exceeds the calibration range.
Q - indicates ion abundance ratio did not meet acceptance criteria. This analyte has been reported as an "estimated maximum possible concentration" (EMPC) since its quantitation was based on a theoretical ion abundance ratio.
C - indicates results for these analyte were reported from confirmation analyses that occurred after initial analysis

Notes:
See page 3.

Table 3
PCB Dioxin-Like Congener Data
Hercules Research Center
Wilmington, Delaware

Congener Concentration Data

Area of Concern		**SWMU-4**	**SWMU-4**	**SWMU-4**	**SWMU-4**	**SWMU-4**	**SWMU-9D**	**SWMU-9D**	**SWMU-9D**	**SWMU-9D**	**SWMU-9D**
Sample ID		**SS-1**	**SS-2**	**SS-11**	**SB-12**	**SB-13**	**SS-3**	**SS-4**	**SS-5**	**SS-6**	**SS-7**
Sampling Date:		**11/20/2003**	**11/20/2003**	**1/7/2004**	**1/7/2004**	**1/7/2004**	**11/20/2003**	**11/20/2003**	**11/18/2003**	**11/18/2003**	**11/18/2003**
Parameter	**CAS #**										
PCB Congener 77	32598-13-3	ND	ND J	11.42 D	ND J	0.45	ND	ND	ND	ND J	NA
PCB Congener 81	70362-50-4	ND	ND J	ND	ND J	ND	ND	ND	ND	ND J	NA
PCB Congener 105	32598-14-4	26.27 D	81.07 DJ	905.89 D	1.28 J	15.68	0.46	1.18	23.26 D	21.41 J	NA
PCB Congener 114	74472-37-0	ND	ND J	53.91 D	ND	0.88	ND	ND	ND	ND J	NA
PCB Congener 106/118	31508-00-6	77.82 D	236.80 DJ	3,088.46 DJ	4.46 J	47.50 J	1.71	3.73	61.07 D	58.98 J	NA
PCB Congener 107/123		ND	ND J	ND	ND	ND	ND	ND	ND	ND J	NA
PCB Congener 126	57465-28-8	ND	ND J	ND	0.33	ND	ND	ND	ND	ND J	NA
PCB Congener 156	38380-08-4	15.22	31.40 DJ	229.77 D	1.54	6.72	0.27 J	0.60	12.14	5.47 J	NA
PCB Congener 157	69782-90-7	ND	ND J	ND	ND	ND	ND	ND	ND	ND J	NA
PCB Congener 167	52663-72-6	ND	ND J	ND	0.92	2.79	0.16 J	0.27 J	ND	ND J	NA
PCB Congener 169	32774-16-6	ND	ND J	ND	ND	ND	ND	ND	ND	ND J	NA
PCB Congener 189	39635-31-9	0.86	3.44	13.64 D	0.56	0.65	ND	ND	0.70	ND	NA

ND = Not detected
J = Estimated concentration
D = Sample dilution required
BGS = Below ground surface
All results in nanograms per gram (ppb)

Congener Concentration Data (from above) with TEFs Applied

Area of Concern		**SWMU-4**	**SWMU-4**	**SWMU-4**	**SWMU-4**	**SWMU-4**	**SWMU-9D**	**SWMU-9D**	**SWMU-9D**	**SWMU-9D**	**SWMU-9D**
Sample ID		**SS-1**	**SS-2**	**SS-11**	**SB-12**	**SB-13**	**SS-3**	**SS-4**	**SS-5**	**SS-6**	**SS-7**
Sampling Date:		**11/20/2003**	**11/20/2003**	**1/7/2004**	**1/7/2004**	**1/7/2004**	**11/20/2003**	**11/20/2003**	**11/18/2003**	**11/18/2003**	**11/18/2003**
Parameter	**TEF**										
PCB Congener 77	0.0001	ND	ND J	1.14E-03 D	ND J	4.50E-05	ND	ND	ND	ND J	NA
PCB Congener 81	0.0001	ND	ND J	ND	ND J	ND	ND	ND	ND	ND J	NA
PCB Congener 105	0.0001	2.63E-03 D	8.11E-03 DJ	9.06E-02 D	1.28E-04 J	1.57E-03	4.60E-05	1.18E-04	2.33E-03 D	2.14E-03 J	NA
PCB Congener 114	0.0005	ND	ND J	2.70E-02 D	ND	4.40E-04	ND	ND	ND	ND J	NA
PCB Congener 106/118	0.0001	7.78E-03 D	2.37E-02 DJ	3.09E-01 DJ	4.46E-04 J	4.75E-03 J	1.71E-04	3.73E-04	6.11E-03 D	5.90E-03 J	NA
PCB Congener 107/123	0.0001	ND	ND J	ND	ND	ND	ND	ND	ND	ND J	NA
PCB Congener 126	0.1	ND	ND J	ND	3.30E-02	ND	ND	ND	ND	ND J	NA
PCB Congener 156	0.0005	7.61E-03	1.57E-02 DJ	1.15E-01 D	7.70E-04	3.36E-03	1.35E-04 J	3.00E-04	6.07E-03	2.74E-03 J	NA
PCB Congener 157	0.0005	ND	ND J	ND	ND	ND	ND	ND	ND	ND J	NA
PCB Congener 167	0.00001	ND	ND J	ND	9.20E-06	2.79E-05	1.60E-06 J	2.70E-06 J	ND	ND J	NA
PCB Congener 169	0.01	ND	ND J	ND	ND	ND	ND	ND	ND	ND J	NA
PCB Congener 189	0.0001	8.60E-05	3.44E-04	1.36E-03 D	5.60E-05	6.50E-05	ND	ND	7.00E-05	ND	NA
Total PCB TEC in ug/kg		1.81E-02	4.78E-02 J	5.44E-01	3.44E-02	1.03E-02	3.54E-04	7.94E-04	1.46E-02	1.08E-02 J	NA
Total PCB TCDD TEC in mg/kg:		**1.81E-05**	**4.78E-05**	**5.44E-04**	**3.44E-05**	**1.03E-05**	**3.54E-07**	**7.94E-07**	**1.46E-05**	**1.08E-05**	**NA**
Total Dioxin/Furan TCDD TEC in mg/kg (Table 2):		**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**9.18E-05**	**2.35E-06**
Total TCDD TEC in mg/kg:		**1.81E-05**	**4.78E-05**	**5.44E-04**	**3.44E-05**	**1.03E-05**	**3.54E-07**	**7.94E-07**	**1.46E-05**	**1.03E-04**	**2.35E-06**

Notes:
See page 2.

Table 3
PCB Dioxin-Like Congener Data
Hercules Research Center
Wilmington, Delaware

Congener Concentration Data

Area of Concern		**SWMU-12**	**SWMU-12**	**SWMU-12**	**SWMU-12**	**SWMU-12**	**SWMU-12**	**SWMU-12**	**SWMU-12**	**SWMU-12**	**SWMU-12**	**AOC-B**	**AOC-B**	**AOC-E**
Sample ID		**SS-3**	**SS-4**	**SS-5**	**SS-6**	**SS-7**	**SS-8**	**SS-9**	**SS-10**	**SS-13**	**SS-14**	**SS-6**	**SS-7**	**SS-1**
Sampling Date:		**11/18/2003**	**11/18/2003**	**11/20/2003**	**11/20/2003**	**11/20/2003**	**11/20/2003**	**11/20/2003**	**11/20/2003**	**11/18/2003**	**11/18/2003**	**11/18/2003**	**11/18/2003**	**11/20/2003**
Parameter	**CAS #**													
PCB Congener 77	32598-13-3	ND	ND	5.69	1.51	ND	5.19	10.87 D	1.84	ND	ND	ND	ND	3.29 D
PCB Congener 81	70362-50-4	ND	ND	ND	1.98	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 105	32598-14-4	4.55	2.70	132.89 D	45.69 D	0.50	260.29 D	1,031.83 D	54.28 D	ND	0.05 J	63.62 D	33.12 D	174.45 D
PCB Congener 114	74472-37-0	ND	ND	9.07	2.61	ND	15.56	ND	3.56	ND	ND	ND	ND	11.82 D
PCB Congener 106/118	31508-00-6	13.08	7.56	375.86 D	125.06 D	1.39	803.02 D	3,237.85 D	160.68 D	ND	0.14 J	179.62 D	90.07 D	557.42 D
PCB Congener 107/123		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 126	57465-28-8	ND	ND	2.35	0.59	ND	2.82	11.99 D	ND	ND	ND	ND	ND	ND
PCB Congener 156	38380-08-4	1.55	1.25	38.39 D	14.89	0.28	104.60 D	301.23 D	18.65	ND	ND	22.87	14.25	91.09 D
PCB Congener 157	69782-90-7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 167	52663-72-6	ND	ND	15.70	6.02	0.11 J	41.01 D	111.62 D	7.00	ND	ND	ND	ND	38.43 D
PCB Congener 169	32774-16-6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 189	39635-31-9	ND	ND	3.82	1.35	ND	7.70	18.47 D	1.51	ND	ND	2.57	1.58	17.91 D

ND = Not detected
J = Estimated concentration
D = Sample dilution required
BGS = Below ground surface
All results in nanograms per gram (ppb)

Congener Concentration Data (from above) with TEFs

Area of Concern		**SWMU-12**	**SWMU-12**	**SWMU-12**	**SWMU-12**	**SWMU-12**	**SWMU-12**	**SWMU-12**	**SWMU-12**	**SWMU-12**	**SWMU-12**	**AOC-B**	**AOC-B**	**AOC-E**
Sample ID		**SS-3**	**SS-4**	**SS-5**	**SS-6**	**SS-7**	**SS-8**	**SS-9**	**SS-10**	**SS-13**	**SS-14**	**SS-6**	**SS-7**	**SS-1**
Sampling Date:		**11/18/2003**	**11/18/2003**	**11/20/2003**	**11/20/2003**	**11/20/2003**	**11/20/2003**	**11/20/2003**	**11/20/2003**	**11/18/2003**	**11/18/2003**	**11/18/2003**	**11/18/2003**	**11/20/2003**
Parameter	**TEF**													
PCB Congener 77	0.0001	ND	ND	5.69E-04	1.51E-04	ND	5.19E-04	1.09E-03 D	1.84E-04	ND	ND	ND	ND	3.29E-04 D
PCB Congener 81	0.0001	ND	ND	ND	1.98E-04	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 105	0.0001	4.55E-04	2.70E-04	1.33E-02 D	4.57E-03 D	5.00E-05	2.60E-02 D	1.03E-01 D	5.43E-03 D	ND	5.00E-06 J	6.36E-03 D	3.31E-03 D	1.74E-02 D
PCB Congener 114	0.0005	ND	ND	4.54E-03	1.31E-03	ND	7.78E-03	ND	1.78E-03	ND	ND	ND	ND	5.91E-03 D
PCB Congener 106/118	0.0001	1.31E-03	7.56E-04	3.76E-02 D	1.25E-02 D	1.39E-04	8.03E-02 D	3.24E-01 D	1.61E-02 D	ND	1.40E-05 J	1.80E-02 D	9.01E-03 D	5.57E-02 D
PCB Congener 107/123	0.0001	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 126	0.1	ND	ND	2.35E-01	5.90E-02	ND	2.82E-01	1.20E+00 D	ND	ND	ND	ND	ND	ND
PCB Congener 156	0.0005	7.75E-04	6.25E-04	1.92E-02 D	7.45E-03	1.40E-04	5.23E-02 D	1.51E-01 D	9.33E-03	ND	ND	1.14E-02	7.13E-03	4.55E-02 D
PCB Congener 157	0.0005	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 167	0.00001	ND	ND	1.57E-04	6.02E-05	1.10E-06 J	4.10E-04 D	1.12E-03 D	7.00E-05	ND	ND	ND	ND	3.84E-04 D
PCB Congener 169	0.01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 189	0.0001	ND	ND	3.82E-04	1.35E-04	ND	7.70E-04	1.85E-03 D	1.51E-04	ND	ND	2.57E-04	1.58E-04	1.79E-03 D
Total PCB TEC in ug/kg		2.54E-03	1.65E-03	3.11E-01	8.54E-02	3.30E-04	4.50E-01	1.78E+00	3.30E-02	0.00E+00	1.90E-05	3.60E-02	1.96E-02	1.27E-01
Total PCB TCDD TEC in mg/kg:		**2.54E-06**	**1.65E-06**	**3.11E-04**	**8.54E-05**	**3.30E-07**	**4.50E-04**	**1.78E-03**	**3.30E-05**	**0.00E+00**	**1.90E-08**	**3.60E-05**	**1.96E-05**	**1.27E-04**
Total Dioxin/Furan TCDD TEC in mg/kg (Table 2):		**6.64E-05**	**3.64E-06**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**2.50E-05**	**NA**	**NA**
Total TCDD TEC in mg/kg:		**6.89E-05**	**5.29E-06**	**3.11E-04**	**8.54E-05**	**3.30E-07**	**4.50E-04**	**1.78E-03**	**3.30E-05**	**0.00E+00**	**1.90E-08**	**6.10E-05**	**1.96E-05**	**1.27E-04**

Notes:
See page 2.

Table 3
PCB Dioxin-Like Congener Data
Hercules Research Center
Wilmington, Delaware

Congener Concentration Data

Area of Concern		AOC-F		AOC-F	
Sample ID		**SS-20**		**SS-21**	
Sampling Date:		**11/21/2003**		**11/21/2003**	
Parameter	**CAS #**				
PCB Congener 77	32598-13-3	0.33	J	3.41	
PCB Congener 81	70362-50-4	ND		ND	
PCB Congener 105	32598-14-4	6.72		78.98	D
PCB Congener 114	74472-37-0	0.44		5.16	
PCB Congener 106/118	31508-00-6	22.16		220.16	D
PCB Congener 107/123		ND		ND	
PCB Congener 126	57465-28-8	0.52		1.95	
PCB Congener 156	38380-08-4	4.50		29.29	
PCB Congener 157	69782-90-7	ND		ND	
PCB Congener 167	52663-72-6	2.03		12.34	
PCB Congener 169	32774-16-6	ND		ND	
PCB Congener 189	39635-31-9	0.78		2.76	

ND = Not detected
J = Estimated concentration
D = Sample dilution required
BGS = Below ground surface
All results in nanograms per gram (ppb)

Congener Concentration Data (from above) with TEFs

Area of Concern		AOC-F		AOC-F	
Sample ID		**SS-20**		**SS-21**	
Sampling Date:		**11/21/2003**		**11/21/2003**	
Parameter	**TEF**				
PCB Congener 77	0.0001	3.30E-05	J	3.41E-04	
PCB Congener 81	0.0001	ND		ND	
PCB Congener 105	0.0001	6.72E-04		7.90E-03	D
PCB Congener 114	0.0005	2.20E-04		2.58E-03	
PCB Congener 106/118	0.0001	2.22E-03		2.20E-02	D
PCB Congener 107/123	0.0001	ND		ND	
PCB Congener 126	0.1	5.20E-02		1.95E-01	
PCB Congener 156	0.0005	2.25E-03		1.46E-02	
PCB Congener 157	0.0005	ND		ND	
PCB Congener 167	0.00001	2.03E-05		1.23E-04	
PCB Congener 169	0.01	ND		ND	
PCB Congener 189	0.0001	7.80E-05		2.76E-04	
Total PCB TEC in ug/kg		5.75E-02		2.43E-01	
Total PCB TCDD TEC in mg/kg:		**5.75E-05**		**2.43E-04**	
Total Dioxin/Furan TCDD TEC in mg/kg (Table 2):		**NA**		**NA**	
Total TCDD TEC in mg/kg:		**5.75E-05**		**2.43E-04**	

Notes:
See page 2.

Table 3a
PCB Non-Dioxin-Like Congener Data
Hercules Research Center
Wilmington, Delaware

Area of Concern	SWMU-4	SWMU-4	SWMU-4	SWMU-4	SWMU-4	SWMU-9D	SWMU-9D	SWMU-9D	SWMU-9D	SWMU-12	SWMU-12	SWMU-12	SWMU-12	SWMU-12
Sample ID	**SS-1**	**SS-2**	**SS-11**	**SB-12**	**SB-13**	**SS-3**	**SS-4**	**SS-5**	**SS-6**	**SS-3**	**SS-4**	**SS-5**	**SS-6**	**SS-7**
Sample Depth (ft. bgs):			**0.5-1**	**0.5-1**	**0.5-1**									
Sampling Date:	**11/20/2003**	**11/20/2003**	**1/7/2004**	**1/7/2004**	**1/7/2004**	**11/20/2003**	**11/20/2003**	**11/18/2003**	**11/18/2003**	**11/18/2003**	**11/18/2003**	**11/20/2003**	**11/20/2003**	**11/20/2003**
Parameter														
NON-DIOXIN-LIKE CONGENERS														
Chlorination 1														
PCB Congener 1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorination 2														
PCB Congener 4/10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 6	ND	ND	1.24 D	ND	ND	ND	0.25 J	ND	ND	ND	ND	0.13 J	0.35	ND
PCB Congener 7/9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.09 J	ND	ND	ND
PCB Congener 8	0.40	0.86	5.97 D	0.14 J	0.35	0.14 J	0.13 J	0.33 J	0.20 J	0.17 J	0.14 J	0.54	1.27	
PCB Congener 11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 15	0.17 J	ND	1.43 D	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.49	0.07 J
Chlorination 3														
PCB Congener 16	0.12 J	ND	3.07 D	ND	ND	ND	ND	ND	ND	ND	ND	0.10 J	0.17 J	ND
PCB Congener 17	0.15 J	0.30 J	3.62 D	ND	0.08 J	ND	ND	0.07 J	ND	ND	ND	0.11 J	0.18 J	0.08 J
PCB Congener 18	0.74	1.42	15.47 D	0.14 J	0.43	ND	0.16 J	0.27 J	0.22 J	0.15 J	0.13 J	0.61	0.80	0.37
PCB Congener 19	ND	ND	1.08 D	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 20/33	ND	ND	9.54 D	ND	ND	ND	0.09 J	ND	ND	ND	ND	0.49	0.45	0.08 J
PCB Congener 21	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 22	ND	ND	4.87 D	ND	ND	ND	ND	ND	ND	ND	ND	0.37	0.55	ND
PCB Congener 23/34	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 24/27	0.09 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 25	ND	ND	1.13 D	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 26	ND	ND	2.44 D	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 28/31	1.63	3.08	32.20 D	0.17 J	0.48	0.11 J	0.27 J	0.72	0.53	0.25 J	0.15 J	2.25	1.99	0.27
PCB Congener 29	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 30	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 32	0.19 J	ND	3.56 D	ND	ND	ND	ND	ND	ND	ND	ND	0.12 J	0.23 J	ND
PCB Congener 35	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 36	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 37	0.29 J	0.68	3.58 D	ND	ND	ND	0.51	ND	ND	ND	ND	0.57	0.69	ND
PCB Congener 38	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorination 4														
PCB Congener 39	ND	ND J	34.26 D	ND J	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND
PCB Congener 40	0.58	1.12 J	12.45 D	ND J	ND	0.25 J	ND	0.54	0.49 J	0.11 J	0.28 J	1.82	0.58	0.18 J
PCB Congener 41/64/71/72	5.19	9.95 J	111.65 D	0.22 J	2.16	ND	0.08	4.34	3.77 J	0.45	0.34	18.79	6.28	0.08
PCB Congener 42	0.99	1.84 J	18.55 D	ND J	0.26 J	ND	ND	0.74	0.66 J	0.13 J	0.10 J	2.84	1.09	ND
PCB Congener 43/52	28.68 D	81.66 DJ	960.29 D	1.05 J	14.82	0.38	0.75	31.61	27.42 J	3.56	2.14	141.72 D	48.79 D	0.41
PCB Congener 44	15.26	27.53 J	355.96 D	0.23 JJ	3.75	0.11 J	0.26 J	12.54	11.68 J	1.47	0.96	55.31 D	14.65	0.20 J
PCB Congener 45	0.26 J	0.41 J	ND	ND J	ND	ND	ND	0.18 J	0.11 JJ	ND	ND	0.41	0.31	ND
PCB Congener 46	0.12 J	0.20 JJ	2.25 D	ND J	ND	ND	ND	ND	ND J	ND	ND	0.25 J	ND	ND
PCB Congener 47/48/62/65/75	1.43	2.44 J	26.39 D	ND J	ND	ND	ND	1.00	0.84 J	0.15 J	0.10 J	4.16	1.25	ND
PCB Congener 49	8.51	15.38 J	180.07 D	0.16 JJ	2.72	0.11 J	0.21 J	7.24	5.94 J	0.86	0.46	31.79 D	7.25	0.11 J
PCB Congener 50	ND	ND J	ND	ND J	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND
PCB Congener 51	ND	ND J	1.43 D	ND J	ND	ND	ND	ND	ND J	ND	ND	0.17 J	0.05 J	ND
PCB Congener 53	0.69	1.18 J	14.73 D	ND J	ND	ND	ND	0.61	0.56 J	0.06 J	0.04 J	1.88	0.82	ND
PCB Congener 54	ND	ND J	ND	ND J	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND
PCB Congener 55	ND	ND J	ND	ND J	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND
PCB Congener 56/60	5.09	11.63 J	108.19 D	0.22 JJ	1.38	ND	0.23 J	4.17	3.18 J	0.66	0.35	19.57	5.80	0.15 J
PCB Congener 57	ND	ND J	ND	ND J	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND
PCB Congener 58	ND	ND J	ND	ND J	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND
PCB Congener 59	ND	ND J	ND	ND J	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND
PCB Congener 61	ND	ND J	ND	ND J	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND
PCB Congener 63	0.42	0.66 J	7.77 D	ND J	ND	ND	ND	0.35	0.26 JJ	ND	ND	1.27	0.34	ND
PCB Congener 66	8.32	23.34 J	220.72 D	0.22 JJ	1.85	0.06 J	0.39	6.37	4.94 J	0.88	0.36	34.20 D	8.19	0.12 J
PCB Congener 67	ND	ND J	ND	ND J	ND	ND	ND	ND	ND J	ND	ND	0.17 J	ND	ND
PCB Congener 68	ND	ND J	ND	ND J	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND
PCB Congener 69/73	ND	ND J	ND	ND J	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND
PCB Congener 70	27.92 D	90.08 DJ	903.29 D	1.35 J	12.10	0.36	0.98	32.54	26.07 J	4.38	2.19	157.94 D	40.76 D	0.42

Table 3a
PCB Non-Dioxin-Like Congener Data
Hercules Research Center
Wilmington, Delaware

Area of Concern	**SWMU-4**	**SWMU-4**	**SWMU-4**	**SWMU-4**	**SWMU-4**	**SWMU-9D**	**SWMU-9D**	**SWMU-9D**	**SWMU-9D**	**SWMU-12**	**SWMU-12**	**SWMU-12**	**SWMU-12**	**SWMU-12**
Sample ID	**SS-1**	**SS-2**	**SS-11**	**SB-12**	**SB-13**	**SS-3**	**SS-4**	**SS-5**	**SS-6**	**SS-3**	**SS-4**	**SS-5**	**SS-6**	**SS-7**
Sample Depth (ft. bgs):			**0.5-1**	**0.5-1**	**0.5-1**									
Sampling Date:	**11/20/2003**	**11/20/2003**	**1/7/2004**	**1/7/2004**	**1/7/2004**	**11/20/2003**	**11/20/2003**	**11/18/2003**	**11/18/2003**	**11/18/2003**	**11/18/2003**	**11/20/2003**	**11/20/2003**	**11/20/2003**
Parameter														
PCB Congener 74	8.04	15.20 J	170.11 D	0.27 JJ	1.81	ND	0.37	6.68	5.56 J	0.66	0.43	34.91 D	7.75	0.09 J
PCB Congener 76	ND	ND J	ND	ND J	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND
PCB Congener 78	ND	ND J	ND	ND J	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND
PCB Congener 79	ND	ND J	ND	ND J	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND
PCB Congener 80	ND	ND J	ND	ND J	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND
Chlorination 5														
PCB Congener 82	7.78	18.79 J	ND	0.24 J	2.11	ND	0.17 J	6.66	4.25 J	0.89	0.65	26.19 D	9.23	0.12 J
PCB Congener 83/109	3.95	8.70 J	86.35 D	0.15 J	1.26	ND	ND	3.05	2.02 J	0.42	0.27 J	13.22	4.21	ND
PCB Congener 84/92	23.41 D	71.78 DJ	ND	1.68	12.98	0.37	0.77	27.00	17.79 J	3.28	2.51	110.41 D	46.23 D	0.43
PCB Congener 85	14.80	28.47 DJ	270.15 D	0.56	6.08	0.21 J	0.42	14.68	7.93 J	1.75	0.98	49.43 D	14.25	0.20 J
PCB Congener 86/97	27.73	54.15 DJ	606.42 D	0.97 J	7.98	0.29 J	0.70	21.75	14.36 J	3.07	1.87	86.32 D	33.44 D	0.34
PCB Congener 87	32.87 D	101.86 DJ	1,109.19 D	1.74	16.85	0.46	1.07	24.16 D	24.56 J	5.03	3.43	155.91 D	59.85 D	0.62
PCB Congener 88/95	49.92 D	151.21 DJ	1,961.78 D	5.52	30.39	0.83	1.52	32.36 D	35.06 J	5.93	4.85	242.13 D	100.25 D	0.87
PCB Congener 89/90	ND	ND J	35.96 D	ND	0.91	ND	ND	ND	ND J	ND	ND	ND	1.77	ND
PCB Congener 91	10.46	23.49 J	240.48 D	0.38	4.03	0.10 J	0.21 J	8.15	5.52 J	0.99	0.70	33.26 D	11.06	0.13 J
PCB Congener 93/98/102	ND	ND J	ND	ND	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND
PCB Congener 94	ND	ND J	ND	ND	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND
PCB Congener 96	0.44	0.71 J	8.81 D	ND	ND	ND	ND	0.39	ND J	ND	ND	1.26	0.56	ND
PCB Congener 99	27.48 D	80.29 DJ	1,089.06 D	1.42	16.21	0.52	1.22	22.28 D	22.65 J	4.94	2.71	140.10 D	44.63 D	0.45
PCB Congener 100	0.13 J	0.22 JJ	2.35 D	ND	ND	ND	ND	0.09 J	0.08 JJ	ND	ND	0.43	0.13 J	ND
PCB Congener 101	74.13 D	217.59 DJ	2,898.55 D	7.30	43.56	1.34	2.71	48.51 D	51.61 J	10.80	7.24	352.35 D	125.57 D	1.22
PCB Congener 104	ND	ND J	ND	ND	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND
PCB Congener 108/124	5.23	11.53 J	89.50 D	ND	ND	ND	ND	4.58	2.57 J	0.80	0.54	ND	ND	ND
PCB Congener 110	84.58 D	273.11 DJ	3,454.35 D	9.12 J	49.88	1.31	2.59	57.79 D	61.56 J	14.44	8.76	426.15 D	162.56 D	1.65
PCB Congener 111	ND	ND J	ND	ND	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND
PCB Congener 112	ND	ND J	ND	ND	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND
PCB Congener 113	ND	ND J	ND	ND	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND
PCB Congener 115/117	ND	101.86 J	ND	ND	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND
PCB Congener 116	ND	ND J	ND	ND	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND
PCB Congener 119	1.85	4.12 J	36.20 D	ND	0.88	ND	ND	1.41	0.94 J	0.20 J	ND	7.18	1.76	ND
PCB Congener 120	ND	ND J	ND	ND	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND
PCB Congener 121	ND	ND J	ND	ND	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND
PCB Congener 122	ND	ND J	21.67 D	ND	0.47	ND	ND	ND	ND J	ND	ND	3.53	1.07	ND
PCB Congener 125	ND	ND J	ND	ND	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND
PCB Congener 127	ND	ND J	ND	ND	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND
Chlorination 6														
PCB Congener 128	25.67	53.22 DJ	396.84 D	2.85	11.53	0.47	1.03	22.53	10.24 J	2.87	2.05	68.75 D	27.65	0.45
PCB Congener 129	ND	ND J	85.80 D	0.56	1.66	ND	ND	ND	ND J	ND	ND	14.96	5.53	0.12 J
PCB Congener 130	5.97	14.23 J	99.18 D	0.89	2.98	ND	0.25 J	5.02	2.32 J	0.67	0.47	16.75	6.52	0.12 J
PCB Congener 131	ND	ND J	39.51 D	ND	0.55	ND	ND	ND	ND J	ND	ND	5.23	1.93	ND
PCB Congener 132/153/168	68.00 D	321.34 DJ	2,655.16 D	38.10	73.22	2.91	5.54	52.66 D	45.01 J	13.45	9.64	462.29 D	165.21 D	2.16
PCB Congener 133	ND	ND J	ND	ND	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND
PCB Congener 134/143	ND	ND J	ND	ND	ND	ND	ND	ND	ND J	ND	ND	20.80	6.24	ND
PCB Congener 135	10.53	31.59 J	229.65 D	3.05	6.23	0.32	0.41	6.82	3.50 J	1.05	0.85	36.49 D	12.98	0.21 J
PCB Congener 136	14.06	37.30 DJ	342.82 D	4.55	8.06	0.31	0.57	9.35	5.20 J	1.28	1.21	54.41 D	18.84	0.28
PCB Congener 137	6.16	13.59 J	103.72 D	0.44	2.38	ND	0.22 J	5.44	2.60 J	0.67	0.46	16.81	6.49	0.09 J
PCB Congener 138/158/163/164	75.84 D	305.97 DJ	2,296.07 D	26.11	65.33	2.21	4.22	58.59 D	47.67 J	13.54	10.63	402.02 D	155.52 D	1.98
PCB Congener 139/149	42.97 D	181.21 DJ	1,884.24 DJ	24.66 J	41.50 J	1.58	3.73	27.45 D	24.46 J	6.59	5.29	306.71 D	110.45 D	1.30
PCB Congener 140	ND	ND J	ND	ND	ND	ND	ND	ND	ND J	ND	ND	1.30	ND	ND
PCB Congener 141	16.03	45.25 DJ	331.80 D	5.99	8.81	0.40	0.68	12.02	5.33 J	1.77	1.43	62.43 D	22.21	0.38
PCB Congener 142	ND	ND J	ND	ND	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND
PCB Congener 144	3.22	12.44 J	72.31 D	1.21	1.62	ND	0.14 J	1.91	1.01 J	0.27 J	0.24 J	16.62	4.25	0.09 J
PCB Congener 145	ND	ND J	ND	ND	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND
PCB Congener 146	ND	ND J	236.07 D	3.60	7.53	0.30 J	ND	ND	ND J	ND	ND	41.84 D	14.53	0.23 J
PCB Congener 147	ND	ND J	ND	ND	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND
PCB Congener 148	ND	ND J	ND	ND	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND
PCB Congener 150	ND	ND J	ND	ND	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND
PCB Congener 151	14.15	41.46 DJ	368.99 D	7.39	ND	0.46	0.69	9.32	4.42 J	1.11	1.17	64.35 D	19.26	0.32
PCB Congener 152	ND	ND	2.13 D	ND	ND	ND	ND	ND	ND JJ	ND	ND	ND	ND	ND
PCB Congener 154	0.99	2.22	19.17 D	ND	0.37	ND	ND	0.67	0.32 J	0.08 J	0.05 J	3.03	0.87	ND
PCB Congener 155	ND	ND	ND	ND	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND
PCB Congener 159	ND	ND J	ND	ND	ND	ND	ND	ND	ND J	ND	ND	2.82	ND	ND
PCB Congener 160	20.49 D	92.50 DJ	620.65 D	10.58	22.60	0.81	1.40	27.30	11.98 J	3.59	2.60	123.22 D	47.85 D	0.65

Table 3a
PCB Non-Dioxin-Like Congener Data
Hercules Research Center
Wilmington, Delaware

Area of Concern	**SWMU-4**	**SWMU-4**	**SWMU-4**	**SWMU-4**	**SWMU-4**	**SWMU-9D**	**SWMU-9D**	**SWMU-9D**	**SWMU-9D**	**SWMU-12**	**SWMU-12**	**SWMU-12**	**SWMU-12**	**SWMU-12**
Sample ID	**SS-1**	**SS-2**	**SS-11**	**SB-12**	**SB-13**	**SS-3**	**SS-4**	**SS-5**	**SS-6**	**SS-3**	**SS-4**	**SS-5**	**SS-6**	**SS-7**
Sample Depth (ft. bgs):			**0.5-1**	**0.5-1**	**0.5-1**									
Sampling Date:	**11/20/2003**	**11/20/2003**	**1/7/2004**	**1/7/2004**	**1/7/2004**	**11/20/2003**	**11/20/2003**	**11/18/2003**	**11/18/2003**	**11/18/2003**	**11/18/2003**	**11/20/2003**	**11/20/2003**	**11/20/2003**
Parameter														
PCB Congener 161	ND	ND J	ND	ND	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND
PCB Congener 162	ND	ND J	ND	ND	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND
PCB Congener 165	ND	ND J	ND	ND	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND
PCB Congener 166	ND	ND J	ND	ND	ND	ND	ND	ND	ND J	ND	ND	1.57	0.73	ND
Chlorination 7														
PCB Congener 170/190	20.32	76.44 D	376.94 D	15.84	16.76	0.84	1.33	15.54	7.16 J	2.31	2.11	103.94 D	26.83	0.71
PCB Congener 171	4.83	20.71	98.58 D	4.04	4.36	0.20 J	0.36	3.35	1.56	0.64	0.54	26.41	7.85	0.17 J
PCB Congener 172	2.53	10.81	ND	2.28	2.55	ND	0.19 J	2.21	0.95	0.37	0.29 J	13.65	4.06	ND
PCB Congener 173	0.50	1.73	96.29 D	ND	ND	ND	ND	0.35	ND	ND	ND	2.23	0.67	ND
PCB Congener 174	14.50	64.95 D	367.64 D	15.23	14.74	0.78	1.21	11.32	5.08	1.99	1.51	96.14 D	25.76	0.65
PCB Congener 175	0.76	3.75	ND	0.73 J	0.67	ND	ND	0.54	0.34	0.14 J	0.11 J	4.52	1.22	0.09 J
PCB Congener 176	2.43	12.26	75.71 D	2.73	2.57	0.12 J	0.22 J	1.84	0.80	0.32 J	0.31 J	18.23	4.92	0.12 J
PCB Congener 177	8.00	35.56 D	184.74 D	8.16	8.34	0.39	0.62	6.35	2.82	1.12	0.92	50.02 D	13.75	0.34
PCB Congener 178	2.57	14.35	71.03 D	2.74	3.08	0.16 J	ND	ND	ND	ND	ND	19.35	4.36	0.12 J
PCB Congener 179	7.39	43.91	ND	ND	ND	ND	ND	5.59	ND	1.05	0.88	ND	ND	ND
PCB Congener 180/193	29.71	136.78 D	733.08 D	32.27	29.24	1.46	2.26	23.74	10.68 J	4.16	3.37	194.81 D	58.80 D	1.24
PCB Congener 181	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 182/187	11.79	55.28 D	375.75 D	14.14	14.90	0.74	1.11	9.86	4.15 J	1.86	1.34	84.32 D	21.96	0.47
PCB Congener 183	8.47	40.92 D	227.61 D	9.77	8.80	0.39	0.71	6.28	2.86	1.11	1.03	57.97 D	16.69	0.40
PCB Congener 184	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.07 J
PCB Congener 185	ND	ND	44.37 D	1.81	1.77	ND	ND	ND	ND	ND	ND	10.78	2.88	0.08 J
PCB Congener 186	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 188	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 191	0.89	4.03	16.88 D	0.70	ND	ND	ND	0.61	0.32 J	0.14 J	0.10 J	5.14	1.46	ND
Chlorination 8														
PCB Congener 194	3.62	20.13	123.06 D	5.35	4.35	0.21 J	0.34	3.75	2.03	0.62	0.44	26.79	7.09	0.24 J
PCB Congener 195	2.39	9.09	51.93 D	2.72	2.13	ND	ND	1.77	1.54	ND	ND	12.19	3.20	ND
PCB Congener 196/203	4.89	26.86	187.95 D	6.86	5.70	0.32	0.42	4.35	1.96	0.92	0.58	36.25 D	9.80	0.28
PCB Congener 197	0.26 J	1.32	9.69 D	0.37	0.37	ND	ND	0.17 J	0.15 J	ND	ND	1.75	0.50	ND
PCB Congener 199	0.79	4.28	32.87 D	1.07	1.05	ND	ND	0.52	ND	ND	ND	5.69	1.37	ND
PCB Congener 201	0.42	2.30 J	21.41 D	0.66	0.51	ND	0.04 J	0.32 J	0.16 J	0.08 J	ND	3.19	0.94	ND
PCB Congener 202	0.99	4.90	50.52 D	1.20	1.32	0.11 J	0.13 J	1.06	0.39	0.25 J	ND	6.36	1.89	ND
PCB Congener 204	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 205	0.30 J	1.35	7.35 D	0.37	0.48	ND	ND	0.36	0.18 J	ND	ND	1.78	0.50	ND
Chlorination 9														
PCB Congener 206	1.33	4.90 J	36.06 D	0.84	0.97	ND	0.27 J	1.23	0.43	0.41	0.26 J	4.47	2.00	ND
PCB Congener 207	0.22 J	0.96	8.05 D	0.20	0.22 J	ND	ND	0.26 J	ND	ND	ND	0.90	0.37	ND
PCB Congener 208	0.61	2.25	11.83 D	0.21	0.32	ND	0.10 J	0.57	ND	0.18 J	0.09 J	1.05	0.67	ND
Chlorination 10														
PCB Congener 209	0.80	2.86	2.75 D	ND	0.16 J	0.09 J	0.10 J	0.68	0.16 J	0.34 J	0.21 J	0.29	0.30	ND
SUM in ug/kg:	915.43	3,191.84	28,124.33	293.52	615.51	22.53	44.35	724.86	551.11	131.43	92.95	4,670.98	1,614.55	22.02
SUM in mg/kg:	0.92	3.19	28.12	0.29	0.62	0.02	0.04	0.72	0.55	0.13	0.09	4.67	1.61	0.02

ND = Not detected
J = Estimated concentration
D = Sample dilution required
BGS = Below ground surface
All results in nanograms per gram

Table 3a
PCB Non-Dioxin-Like Congener Data
Hercules Research Center
Wilmington, Delaware

Area of Concern	**SWMU-12**	**SWMU-12**	**SWMU-12**	**SWMU-12**	**SWMU-12**	**AOC-B**	**AOC-B**	**AOC-E**	**AOC-F**	**AOC-F**
Sample ID	**SS-8**	**SS-9**	**SS-10**	**SS-13**	**SS-14**	**SS-6**	**SS-7**	**SS-1**	**SS-20**	**SS-21**
Sample Depth (ft. bgs):										
Sampling Date:	**11/20/2003**	**11/20/2003**	**11/20/2003**	**11/18/2003**	**11/18/2003**	**11/18/2003**	**11/18/2003**	**11/20/2003**	**11/21/2003**	**11/21/2003**
Parameter										
NON-DIOXIN-LIKE CONGENERS										
Chlorination 1										
PCB Congener 1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorination 2										
PCB Congener 4/10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 6	ND	0.65 D	ND	ND	ND	0.51	ND	ND	0.13 J	1.41
PCB Congener 7/9	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.49
PCB Congener 8		1.68 D		ND	0.14 J	0.45	0.24 J	1.10 D	0.51	4.58
PCB Congener 11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 13	ND	ND	ND	ND	ND	ND	0.27 J	ND	ND	ND
PCB Congener 14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 15	0.92	2.17 D	ND	ND	ND	0.83	ND	ND	0.11 J	1.19
Chlorination 3										
PCB Congener 16	0.21 J	0.32 J	0.18 J	ND	ND	ND	ND	0.71 D	ND	0.25 J
PCB Congener 17	ND	0.83 D	0.19 J	ND	ND	0.15 J	ND	0.80 D	0.08 J	0.33
PCB Congener 18	0.98	3.37 D	1.01	ND	0.15 J	0.64	0.26 J	3.20 D	0.41	1.10
PCB Congener 19	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 20/33	0.63	2.45 D	0.68	ND	ND	ND	ND	2.12 D	0.18 J	0.76
PCB Congener 21	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 22	0.60	3.62 D	0.81	ND	ND	ND	ND	1.24 D	ND	0.45
PCB Congener 23/34	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 24/27	ND	ND	ND	ND	ND	ND	ND	0.50 D	ND	ND
PCB Congener 25	ND	ND	0.15 J	ND	ND	ND	ND	ND	ND	0.11 J
PCB Congener 26	ND	1.59 D	0.24 J	ND	ND	ND	ND	0.71 D	ND	0.22 J
PCB Congener 28/31	3.49	24.56 D	3.00	ND	0.10 J	2.51	0.88	10.43 D	0.45	2.19
PCB Congener 29	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 30	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 32	0.31 J	0.62 D	0.47	ND	ND	ND	ND	1.09 D	ND	0.28 J
PCB Congener 35	ND	ND	1.05	ND	ND	ND	ND	ND	ND	ND
PCB Congener 36	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 37	0.97	4.43 D	0.87	ND	ND	1.15	0.27 J	1.34 D	0.09 J	0.50
PCB Congener 38	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorination 4										
PCB Congener 39	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 40	1.02	5.08 D	0.91	ND	ND	0.91	0.24 J	3.27 D	0.09 J	0.58
PCB Congener 41/64/71/72	22.65	128.23 D	7.60	ND	ND	5.14	3.31	33.59 D	0.69	6.96
PCB Congener 42	2.05	13.08 D	1.46	ND	ND	1.48	0.50	5.88 D	0.15 J	0.87
PCB Congener 43/52	122.93 D	765.14 D	64.68 D	ND	0.07 J	64.84 D	20.19	273.76 D	5.43	54.10 D
PCB Congener 44	26.33	203.37 D	20.37	ND	ND	19.93	7.04	98.15 D	2.10	15.42
PCB Congener 45	0.49	2.72 D	0.37	ND	ND	0.37	0.09 J	1.39 D	ND	0.23 J
PCB Congener 46	0.19 J	ND	0.18 J	ND	ND	0.22 J	ND	0.82 D	ND	0.12 J
PCB Congener 47/48/62/65/75	3.81	22.57 D	2.09	ND	ND	1.82	0.72	8.72 D	0.24 J	1.30
PCB Congener 49	20.37	146.91 D	10.52	ND	0.03 J	10.21	4.22	53.55 D	1.24	10.30
PCB Congener 50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 51	0.14 J	0.84 D	0.14 J	ND	ND	ND	ND	0.45 D	ND	0.08 J
PCB Congener 53	1.16	7.88 D	0.92	ND	ND	0.88	0.38	4.51 D	0.10 J	0.69
PCB Congener 54	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 55	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 56/60	23.21	118.37 D	9.00	ND	ND	6.93	3.43	27.69 D	0.72	6.73
PCB Congener 57	ND	ND	0.85	ND	ND	ND	ND	ND	ND	ND
PCB Congener 58	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 59	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 61	ND	9.16 D	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 63	1.47	ND	0.67	ND	ND	0.31 J	0.29 J	2.21 D	ND	0.50
PCB Congener 66	48.33 D	204.75 D	13.38	ND	ND	13.87 D	5.56 D	48.13 D	0.85	11.07
PCB Congener 67	0.23 J	1.16 D	0.21 J	ND	ND	0.16 J	ND	0.40 D	ND	0.10 J
PCB Congener 68	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 69/73	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 70	211.73 D	1,029.13 D	66.48 D	ND	ND	56.76 D	24.66	234.41 D	5.53	63.92 D

Table 3a
PCB Non-Dioxin-Like Congener Data
Hercules Research Center
Wilmington, Delaware

Area of Concern	**SWMU-12**	**SWMU-12**	**SWMU-12**	**SWMU-12**	**SWMU-12**	**AOC-B**	**AOC-B**	**AOC-E**	**AOC-F**	**AOC-F**
Sample ID	**SS-8**	**SS-9**	**SS-10**	**SS-13**	**SS-14**	**SS-6**	**SS-7**	**SS-1**	**SS-20**	**SS-21**
Sample Depth (ft. bgs):										
Sampling Date:	**11/20/2003**	**11/20/2003**	**11/20/2003**	**11/18/2003**	**11/18/2003**	**11/18/2003**	**11/18/2003**	**11/20/2003**	**11/21/2003**	**11/21/2003**
Parameter										
PCB Congener 74	29.90	191.69 D	10.49	ND	ND	7.74	4.65	47.76 D	1.04	9.38
PCB Congener 76	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 78	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 79	ND	ND	ND	ND	ND	ND	ND	0.28 J	ND	ND
PCB Congener 80	ND	8.20 D	ND	ND	ND	ND	ND	ND	ND	ND
Chlorination 5										
PCB Congener 82	38.72 D	192.29 D	11.59	ND	ND	15.98	5.38	38.23 D	1.35	12.93
PCB Congener 83/109	18.50	85.13 D	5.25	ND	ND	6.65	2.81	17.89 D	0.65	6.10
PCB Congener 84/92	160.78 D	749.57 D	54.89 D	ND	0.06 J	63.80 D	25.02	208.15 D	6.55	51.59 D
PCB Congener 85	98.16 D	338.36 D	17.24	ND	ND	24.49	12.31	62.07 D	2.70	28.33
PCB Congener 86/97	133.37 D	642.80 D	40.94 D	ND	0.04 J	48.71 D	18.25	133.91 D	4.72	37.92 D
PCB Congener 87	293.98 D	1,245.29 D	73.95 D	ND	0.06 J	84.50 D	34.50 D	273.16 D	9.20	80.79 D
PCB Congener 88/95	324.39 D	1,705.07 D	118.62 D	ND	0.12 J	135.98 D	54.78	604.44 D	15.29	107.87 D
PCB Congener 89/90	12.47	ND	2.14	ND	ND	ND	ND	ND	0.36	2.92
PCB Congener 91	53.81 D	237.41 D	13.06	ND	ND	16.38	7.52	50.12 D	1.65	14.82
PCB Congener 93/98/102	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 94	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 96	1.30	7.95 D	0.58	ND	ND	0.59	0.27 J	2.48 D	ND	0.52
PCB Congener 99	252.27 D	1,084.32 D	55.68 D	ND	0.07 J	70.09 D	31.15	187.39 D	7.47	66.33 D
PCB Congener 100	0.49	3.57 D	0.16 J	ND	ND	0.20 J	ND	0.63 D	ND	0.16 J
PCB Congener 101	624.40 D	2,801.98 D	165.12 D	ND	0.18 J	171.27 D	74.78 D	807.33 D	24.28	177.55 D
PCB Congener 104	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 108/124	ND	ND	ND	ND	ND	8.21	3.78	ND	ND	ND
PCB Congener 110	830.14	3,606.60 D	187.52 D	ND	0.20 J	248.69 D	112.02 D	728.29 D	24.42	226.46 D
PCB Congener 111	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 112	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 113	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 115/117	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 116	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 119	13.18	40.65 D	2.21	ND	ND	3.00	1.47	7.77 D	0.33 J	3.60
PCB Congener 120	ND	ND	ND	ND	ND	ND	ND	804.97 D	ND	ND
PCB Congener 121	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 122	7.37	ND	1.31	ND	ND	ND	ND	5.91 D	0.23 J	2.19
PCB Congener 125	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 127	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorination 6										
PCB Congener 128	184.93 D	546.52 D	30.67	ND	ND	49.62 D	28.68	139.10 D	6.68	48.81 D
PCB Congener 129	35.29 D	106.08 D	6.31	ND	ND	ND	ND	28.48 D	1.26	10.61
PCB Congener 130	44.94 D	130.61 D	7.41	ND	ND	7.24	6.45	35.36 D	1.88	13.15
PCB Congener 131	12.51	37.88 D	2.50	ND	ND	ND	ND	9.75 D	ND	3.06
PCB Congener 132/153/168	994.27 D	3,117.97 D	201.20 D	ND	0.20 J	275.95 D	134.37 D	1,624.65 D	63.88	297.69 D
PCB Congener 133	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 134/143	37.69 D	ND	8.21	ND	ND	ND	ND	ND	1.62	12.81
PCB Congener 135	78.61 D	241.74 D	16.85	ND	ND	23.55	10.74	138.83 D	4.64	24.97
PCB Congener 136	102.87 D	341.38 D	23.76	ND	ND	29.89	15.01	224.92 D	6.79	30.25
PCB Congener 137	42.62 D	ND	7.57	ND	ND	8.80	6.00	24.89 D	1.30	12.17
PCB Congener 138/158/163/164	965.53 D	2,900.89 D	182.02 D	ND	0.15 J	ND	128.31 D	1,124.26 D	48.52	278.52 D
PCB Congener 139/149	535.61 D	1,785.46 D	118.76 D	ND	0.12 J	157.82 D	75.98 D	1,191.11 D	35.58	178.65 D
PCB Congener 140	3.03	8.08 D	0.51	ND	ND	ND	ND	ND	ND	1.01
PCB Congener 141	141.07 D	ND	28.23	ND	ND	37.99 D	21.42	246.45 D	8.76	40.37 D
PCB Congener 142	ND	20.56 D	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 144	32.29	95.97 D	5.98	ND	ND	6.89	3.91	50.38 D	1.97	9.38
PCB Congener 145	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 146	96.30 D	ND	18.20	ND	ND	ND	ND	132.27 D	5.94	29.78 D
PCB Congener 147	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 148	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 150	ND	ND	0.18 J	ND	ND	ND	ND	ND	ND	ND
PCB Congener 151	124.38 D	384.87 D	27.96	ND	ND	34.15 D	18.14	292.87 D	8.49	36.97 D
PCB Congener 152	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 154	6.47	21.33 D	1.10	ND	ND	1.97	0.79	4.11 D	0.24 J	2.10
PCB Congener 155	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 159	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.89
PCB Congener 160	265.79 D	799.70 D	57.15 D	ND	0.06 J	ND	37.95 D	424.95 D	17.97	91.29 D

Table 3a
PCB Non-Dioxin-Like Congener Data
Hercules Research Center
Wilmington, Delaware

Area of Concern	**SWMU-12**	**SWMU-12**	**SWMU-12**	**SWMU-12**	**SWMU-12**	**AOC-B**	**AOC-B**	**AOC-E**	**AOC-F**	**AOC-F**
Sample ID	**SS-8**	**SS-9**	**SS-10**	**SS-13**	**SS-14**	**SS-6**	**SS-7**	**SS-1**	**SS-20**	**SS-21**
Sample Depth (ft. bgs):										
Sampling Date:	**11/20/2003**	**11/20/2003**	**11/20/2003**	**11/18/2003**	**11/18/2003**	**11/18/2003**	**11/18/2003**	**11/20/2003**	**11/21/2003**	**11/21/2003**
Parameter										
PCB Congener 161	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 162	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 165	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 166	4.05	14.53 D	0.74	ND	ND	ND	ND	3.80 D	ND	1.29
Chlorination 7										
PCB Congener 170/190	196.46 D	465.06 D	42.49 D	ND	ND	55.29 D	27.97 D	516.19 D	19.70	68.42 D
PCB Congener 171	49.64 D	119.55 D	9.80	ND	ND	14.26	8.57	125.13 D	4.90	15.85
PCB Congener 172	24.35	60.28 D	5.03	ND	ND	8.61	5.12	66.04 D	2.71	9.53
PCB Congener 173	4.35	ND	0.80	ND	ND	1.34	0.75	10.01 D	0.43	1.56
PCB Congener 174	166.61 D	384.71 D	37.65 D	ND	ND	50.71 D	30.56	481.74 D	17.69	57.29 D
PCB Congener 175	8.32	28.51 D	ND	ND	ND	2.20	1.31	ND	0.79	2.43
PCB Congener 176	31.98	75.66 D	6.69	ND	ND	8.04	4.70	94.16 D	3.34	9.10
PCB Congener 177	89.98 D	203.82 D	17.49	ND	ND	27.17	16.19	244.95 D	9.68	31.88
PCB Congener 178	27.79 D	64.38 D	5.80	ND	ND	ND	ND	84.96 D	3.27	13.07
PCB Congener 179	ND	ND	ND	ND	ND	27.79	15.29	ND	ND	ND
PCB Congener 180/193	345.50 D	785.25 D	74.14 D	ND	ND	98.96 D	51.55 D	980.50 D	35.26	119.07 D
PCB Congener 181	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 182/187	135.04 D	313.32 D	28.90	ND	ND	44.38 D	26.52	426.95 D	16.15	52.64 D
PCB Congener 183	104.88 D	247.05 D	21.69	ND	ND	29.30	17.45	308.13 D	10.76	32.09 D
PCB Congener 184	0.21 J	ND	ND	ND	ND	ND	ND	ND	0.08 J	0.11 J
PCB Congener 185	17.33	40.20 D	3.75	ND	ND	ND	ND	60.39 D	1.91	6.59
PCB Congener 186	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 188	0.22 J	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 191	9.48	21.14 D	1.77	ND	ND	2.60	1.54	23.28 D	0.81	2.97
Chlorination 8										
PCB Congener 194	43.55 D	91.95 D	9.29	ND	ND	16.54	9.04	159.14 D	4.87	15.66
PCB Congener 195	17.92	44.06 D	4.27	ND	ND	6.94	4.41	74.08 D	2.48	8.42
PCB Congener 196/203	60.42 D	128.04 D	12.40	ND	ND	20.29	11.42	210.63 D	6.79	20.87
PCB Congener 197	2.85	7.79 D	0.65	ND	ND	0.98	0.49	12.48 D	0.40	0.91
PCB Congener 199	8.68	19.19 D	1.81	ND	ND	2.99	1.77	32.31 D	1.04	3.40
PCB Congener 201	5.31	12.70 D	1.13	ND	ND	1.63	0.92	20.21 D	0.65	1.65
PCB Congener 202	10.32	24.92 D	2.14	ND	ND	4.27	2.18	35.33 D	1.35	4.30
PCB Congener 204	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB Congener 205	2.35	6.36 D	0.66	ND	ND	1.05	0.75	11.62 D	0.39	1.24
Chlorination 9										
PCB Congener 206	8.93	19.11 D	1.48	ND	ND	8.47	3.83	28.97 D	0.94	3.18
PCB Congener 207	2.12	4.89 D	0.40	ND	ND	1.24	0.59	6.41 D	0.26 J	0.58
PCB Congener 208	3.42	6.76 D	0.46	ND	ND	4.18	1.98	6.73 D	0.36	1.19
Chlorination 10										
PCB Congener 209	7.56	2.19 D	0.20 J	ND	ND	5.91	3.54	3.22 D	0.53	0.69
SUM in ug/kg:	8,481.27	29,376.02	2,005.43	0.00	1.75	2,175.36	1,197.43	14,520.69	482.40	2,626.75
SUM in mg/kg:	8.48	29.38	2.01	ND	0.0018	2.18	1.20	14.52	0.48	2.63

ND = Not detected
J = Estimated concentration
D = Sample dilution required
BGS = Below ground surface
All results in nanograms per gram

Table 4
Summary of Site-Specific Johnson and Ettinger Modeling Input Parameters
Hercules Research Center
Wilmington, Delaware

Site-Specific Input Parameter	**Building 8130 Value**	**Building 8138 Value**	**Building 8143 Value**	**Building 8501 Value**
Depth Below Grade to Bottom of Enclosed Space Floor (cm)	15	15	15	15
Depth Below Grade to Water Table (feet) / (cm)	5 feet / 152.4 cm	4 feet / 121.92 cm	3.5 feet / 106.68 cm	4 feet / 121.92 cm
SCS Soil Type Directly Above the Water Table	Loam	Silt Loam	Loam	Loam
Maximum Concentration in ug/L (Location of Maximum)				
1,1-Dichloroethane	-	-	-	5 (SWMU-9A/15/MW-1)
1,2-Dichloropropane	-	0.67 (SWMU-4/MW-1)	0.67 (SWMU-4/MW-1)	-
2-Butanone	-	-	-	1.8 (MW-5D)
Benzene	11 (MW-9S)	480 (SWMU-4/MW-1)	1100 (MW-7)	1.1 (MW-5S)
Chlorobenzene	180 (MW-9S)	10 (AOC-B/MW-1)	45 (MW-7)	1.1 (PW-15)
cis-1,2-Dichloroethene	8.7 (PW-21)	12 (AOC-B/MW-1)	1.4 (SWMU-4/MW-1)	14 (PW-15)
Ethylbenzene	-	10 (SWMU-4/MW-1)	13 (MW-7)	-
Tetrachloroethene	-	7.3 (MW-8)	7.3 (MW-8)	40 (PW-15)
Toluene	-	26 (SWMU-4/MW-1)	26 (SWMU-4/MW-1)	-
Trichloroethene	-	2 (AOC-B/MW-1)	0.98 (MW-8)	14 (PW-15)
Vinyl Chloride	-	0.93 (AOC-B/MW-1)	-	-
Xylene (total)	-	14 (SWMU-4/MW-1)	14 (SWMU-4/MW-1)	-

Notes:
" - " Not detected within 100-foot radius of building

Table 5
Summary of Johnson and Ettinger Modeling Quantitative Risk Estimates
Hercules Research Center
Wilmington, Delaware

	Building 8130		Building 8138		Building 8143		Building 8501	
	Carcinogrnic Risk	**Noncarcinogenic Hazard Quotient**	**Carcinogrnic Risk**	**Noncarcinogenic Hazard Quotient**	**Carcinogrnic Risk**	**Noncarcinogenic Hazard Quotient**	**Carcinogrnic Risk**	**Noncarcinogenic Hazard Quotient**
1,1-Dichloroethane	-	-	-	-	-	-	NA	9.10E-05
1,2-Dichloropropane	-	-	2.30E-08	8.40E-04	2.30E-08	8.30E-04	-	-
2-Butanone	-	-	-	-	-	-	NA	3.20E-07
Benzene	3.00E-07	3.50E-03	1.40E-05	1.70E-01	3.00E-05	3.60E-01	3.00E-08	3.60E-04
Chlorobenzene	NA	1.60E-02	NA	9.20E-04	NA	4.00E-03	NA	9.80E-05
cis-1,2-Dichloroethene	NA	1.70E-03	NA	2.50E-03	NA	2.80E-04	NA	2.80E-03
Ethylbenzene	-	-	NA	1.10E-04	NA	1.30E-04	-	-
Tetrachloroethene	-	-	3.80E-07	3.00E-04	3.30E-07	2.60E-04	1.80E-06	1.40E-03
Toluene	-	-	NA	7.50E-04	NA	6.70E-04	-	-
Trichloroethene	-	-	1.30E-06	8.40E-04	5.70E-07	3.60E-04	8.10E-06	5.10E-03
Vinyl Chloride	-	-	2.30E-07	7.20E-04	-	-	-	-
Xylene (total)	-	-	NA	1.50E-03	NA	9.40E-05	-	-

Notes:
" - " Not detected within 100-foot radius of building
NA - Not Applicable

Table 6
Site-Specific Dilution Attenuation Factors (DAFs)
Hercules Research Center
Wilmington, Delaware

	AOC-B	AOC-E	AOC-F	SWMU-4	SWMU-7	SWMU-9D	SWMU-12
Model Parameter:							
L = Source Length parallel to ground water flow (m)	26	72	49	49	15	15	14
d_a = Aquifer thickness (m)	3.05	12.84	2.74	6.16	2.67	1.46	5.25
I = Infiltration Rate (m/yr) [default]	0.18	0.18	0.18	0.18	0.18	0.18	0.18
K = Hydraulic Conductivity (m/yr)	156	200.3	233.7	138.0	311.6	39	311.6
i = Hydraulic Gradient (m/m)	0.020	0.070	0.008	0.030	0.0009	0.070	0.0009
Model Outputs:							
d = Mixing Zone Depth (m)	3.92	8.47	7.41	6.96	4.18	2.34	5.86
DAF = Dilution Attenuation Factor	**3.62**	**10.21**	**2.58**	**4.28**	**1.43**	**3.33**	**1.64**

Where:

Mixing Zone Depth, d = $(0.0112*L\^{}^{2})\^{}^{0.5}$ + da {1 - exp(-1*L*I)/(K*i*da)}

Dilution Attenuation Factor, DAF = 1 + (K*i*d)/(I*L)

Source: Soil Screening Level Guidance: Technical Background Document (USEPA, 1996)

Table 7
Site-Specific Soil Screening Level Calculations (SSLs) - AOC B
Hercules Research Center
Wilmington, Delaware

Constituent	**Target Leachate Concentration (mg/L)***	**C_w Target Leachate Conc * DAF (mg/L)**	**Koc/K_d** Soil-water partition coefficient (L/kg)**	**H' Dimensionless Henry's Law Constant**	**Site-Specific SSL (mg/kg)**	**Maximum Concentration (mg/kg)**	**Is Max Conc > SSL ?**
1,2-Dichloroethene (total)	5.50E-02	1.99E-01	5.87E-01	1.67E-01	1.72E-01	2.70E-02	No
4,4-DDD	2.80E-04	1.01E-03	1.34E+04	1.64E-04	1.36E+01	2.60E+00	No
4,4-DDE	2.00E-04	7.24E-04	5.99E+04	8.61E-04	4.34E+01	4.00E+00	No
4,4-DDT	2.00E-04	7.24E-04	3.52E+04	3.32E-04	2.55E+01	7.20E+01	Yes
Aldrin	3.90E-06	1.41E-05	3.28E+04	6.97E-03	4.64E-01	6.70E-04	No
Aroclor 1254	3.30E-05	1.20E-04	1.01E+03	1.16E-02	1.21E-01	2.90E+00	Yes
Arsenic	4.20E-06	1.52E-05	2.90E+01	0.00E+00	4.44E-04	1.03E+01	Yes
Barium	7.30E+00	2.64E+01	4.10E+01	0.00E+00	1.09E+03	7.70E+02	No
beta-BHC	3.70E-05	1.34E-04	1.69E+01	3.05E-05	2.29E-03	3.40E-02	Yes
Cadmium	1.80E-02	6.52E-02	7.50E+01	0.00E+00	4.90E+00	7.10E+00	Yes
Chlorobenzene	9.00E-02	3.26E-01	2.93E+00	1.52E-01	1.05E+00	2.40E-01	No
Chromium	5.50E+01	1.99E+02	1.80E+06	0.00E+00	3.59E+08	1.30E+02	No
Dieldrin	4.20E-06	1.52E-05	2.87E+02	6.19E-04	4.37E-03	7.60E-03	Yes
Dinoseb	3.70E-02	1.34E-01	4.75E+01	1.86E-05	6.39E+00	9.60E-03	No
gamma-BHC (Lindane)	5.20E-05	1.88E-04	1.43E+01	5.74E-04	2.74E-03	8.80E-04	No
Manganese	7.30E-01	2.64E+00	6.50E+01	0.00E+00	1.72E+02	1.58E+03	Yes
Methylene Chloride	4.10E-03	1.49E-02	1.57E-01	8.98E-02	5.92E-03	1.80E-02	Yes
Silver	1.80E-01	6.52E-01	8.30E+00	0.00E+00	5.54E+00	6.25E+00	Yes
Tetrachloroethene	1.00E-04	3.62E-04	2.08E+00	7.54E-01	9.52E-04	1.60E-02	Yes
Thallium	2.60E-03	9.42E-03	7.10E+01	0.00E+00	6.71E-01	9.30E-01	Yes
Toxaphene	6.10E-05	2.21E-04	3.44E+03	2.46E-04	7.61E-01	2.50E+00	Yes
Trichloroethene	2.60E-05	9.42E-05	2.22E+00	4.22E-01	2.47E-04	1.30E-02	Yes
Vanadium	3.70E-02	1.34E-01	1.00E+03	0.00E+00	1.34E+02	2.70E+02	Yes
Vinyl Chloride	1.50E-05	5.43E-05	2.49E-01	1.11E+00	5.26E-05	8.00E-03	Yes

Mixing Zone Depth, $d = (0.0112*L^{2})^{0.5} + da \{1 - \exp(-1*L*I)/(K*i*da)\}$

d = 3.92

Dilution Attenuation Factor, DAF = 1 + (K*i*d)/(I*L)

DAF = 3.62

Where:

L =	26	Source Length parallel to ground water flow (m)
d_a =	3.05	Aquifer thickness (m)
I =	0.18	Infiltration Rate (m/yr) [default]
K =	156	Hydraulic Conductivity (m/yr)
i =	0.020	Hydraulic Gradient (m/m)

Soil Screening Level = C_w * [K_d + (Qw + Qa*H')/(P)]

Where:

Qw =	0.300	Water Filled Porosity (L_{water}/L_{soil}) [default]
Qa =	0.700	Air filled Porosity (L_{air}/L_{soil}) [default]
P =	1.50	Dry Soil Bulk Density (kg/L) [default]

*Region III Risk-Based Concentration for tap water (6 April 2007)

** For organics Kd = Koc * foc, where foc = **0.0134** Fraction Organic Carbon [site-specific, measured]

H' = H * 41 (where 41 is a conversion factor)

Chemical-specific values for Koc, Kd and H' source (hierarchal list):

1. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (OSWER 9355.4-24, Appendix C, 2002)
2. The Risk Assessment Information System (RAIS, Oak Ridge National Laboratory, http://rais.ornl.gov/)
3. Hazardous Substances Data Bank (National Library of Medicine, TOXNET, http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB)

Table 8
Site-Specific Soil Screening Level Calculations (SSLs) - AOC E
Hercules Research Center
Wilmington, Delaware

Constituent	**Target Leachate Concentration (mg/L)***	**C_w Target Leachate Conc * DAF (mg/L)**	**Koc/K_d** Soil-water partition coefficient (L/kg)**	**H' Dimensionless Henry's Law Constant**	**Site-Specific SSL (mg/kg)**	**Maximum Concentration (mg/kg)**	**Is Max Conc > SSL ?**
1,2-Dichloroethene (total)	5.50E-02	5.61E-01	2.25E+00	1.67E-01	1.42E+00	6.40E-01	No
2,4-Dimethylphenol	7.30E-01	7.45E+00	1.07E+01	8.20E-05	8.15E+01	1.05E+00	No
4,4-DDD	2.80E-04	2.86E-03	5.14E+04	1.64E-04	1.47E+02	8.50E-01	No
4,4-DDT	2.00E-04	2.04E-03	1.35E+05	3.32E-04	2.76E+02	3.40E+00	No
Acetone	5.50E+00	5.61E+01	2.96E-02	1.59E-03	1.29E+01	1.30E+00	No
Aldrin	3.90E-06	3.98E-05	1.26E+05	6.97E-03	5.01E+00	4.40E-03	No
alpha-BHC	1.10E-05	1.12E-04	6.32E+01	4.35E-04	7.12E-03	2.15E-03	No
alpha-Chlordane	1.90E-04	1.94E-03	6.17E+03	1.99E-03	1.20E+01	8.85E-02	No
Antimony	1.50E-02	1.53E-01	4.50E+01	0.00E+00	6.92E+00	2.01E+00	No
Aroclor 1254	3.30E-05	3.37E-04	3.89E+03	1.16E-02	1.31E+00	1.50E+01	Yes
Arsenic	4.20E-06	4.29E-05	2.90E+01	0.00E+00	1.25E-03	4.13E+00	Yes
Benzene	3.40E-04	3.47E-03	3.03E+00	2.28E-01	1.16E-02	6.85E-01	Yes
Benzo(a)anthracene	3.00E-05	3.06E-04	2.05E+04	1.37E-04	6.27E+00	4.60E-01	No
Benzo(a)pyrene	3.00E-06	3.06E-05	5.24E+04	4.63E-05	1.61E+00	4.00E-01	No
Benzo(b)fluoranthene	3.00E-05	3.06E-04	6.32E+04	4.55E-03	1.94E+01	5.40E-01	No
beta-BHC	3.70E-05	3.78E-04	6.48E+01	3.05E-05	2.45E-02	2.10E-03	No
Carbazole	N/A	N/A	1.74E+02	6.26E-07	N/A	8.50E-02	No
Chromium	5.50E+01	5.61E+02	1.80E+06	0.00E+00	1.01E+09	5.64E+01	No
delta-BHC	3.70E-05	3.78E-04	5.50E+01	5.74E-04	2.08E-02	2.10E-03	No
Dibenz(a,h)anthracene	3.00E-06	3.06E-05	1.95E+05	6.03E-07	5.98E+00	7.60E-02	No
Dieldrin	4.20E-06	4.29E-05	1.10E+03	6.19E-04	4.72E-02	3.50E-01	Yes
Endrin Aldehyde	1.10E-02	1.12E-01	6.32E+02	3.08E-04	7.10E+01	9.10E-01	No
gamma-BHC (Lindane)	5.20E-05	5.31E-04	5.50E+01	5.74E-04	2.93E-02	3.40E-04	No
Heptachlor Epoxide	7.40E-06	7.55E-05	4.28E+03	3.90E-04	3.23E-01	4.00E-02	No
Indeno(1,2,3-cd)pyrene	3.00E-05	3.06E-04	1.78E+05	6.65E-05	5.46E+01	2.60E-01	No
Manganese	7.30E-01	7.45E+00	6.50E+01	0.00E+00	4.86E+02	5.20E+02	Yes
Methylene Chloride	4.10E-03	4.19E-02	6.01E-01	8.98E-02	3.53E-02	5.70E-02	Yes
Naphthalene	6.50E-03	6.64E-02	1.03E+02	1.98E-02	6.84E+00	2.00E-01	No
Selenium	1.80E-01	1.84E+00	5.00E+00	0.00E+00	9.56E+00	3.47E+00	No
Thallium	2.60E-03	2.65E-02	7.10E+01	0.00E+00	1.89E+00	2.63E+00	Yes
Toxaphene	6.10E-05	6.23E-04	1.32E+04	2.46E-04	8.23E+00	7.50E-01	No
Trichloroethene	2.60E-05	2.65E-04	8.53E+00	4.22E-01	2.37E-03	1.90E-01	Yes
Vanadium	3.70E-02	3.78E-01	1.00E+03	0.00E+00	3.78E+02	2.13E+02	No
Vinyl Chloride	1.50E-05	1.53E-04	9.56E-01	1.11E+00	2.56E-04	1.50E-02	Yes
Xylene (total)	2.10E-01	2.14E+00	2.28E+01	2.71E-01	4.95E+01	5.60E+00	No

Mixing Zone Depth, d = (0.0112*L^2)^0.5 + da {1 - exp(-1*L*I)/(K*i*da)}

d = 8.47

Dilution Attenuation Factor, DAF = 1 + (K*i*d)/(I*L)

DAF = 10.21

Where:

L =	72	Source Length parallel to ground water flow (m)
d_a =	12.84	Aquifer thickness (m)
I =	0.18	Infiltration Rate (m/yr) [default]
K =	200.3	Hydraulic Conductivity (m/yr)
i =	0.070	Hydraulic Gradient (m/m)

Soil Screening Level = C_w * [K_d + (Qw + Qa*H')/(P)]

Where:

Qw =	0.300	Water Filled Porosity (L_{water}/L_{soil}) [default]
Qa =	0.700	Air filled Porosity (L_{air}/L_{soil}) [default]
P =	1.50	Dry Soil Bulk Density (kg/L) [default]

*Region III Risk-Based Concentration for tap water (6 April 2007)

** For organics Kd = Koc * foc, where foc = **0.0514** Fraction Organic Carbon [site-specific, measured]

H' = H * 41 (where 41 is a conversion factor)

Chemical-specific values for Koc, Kd and H' source (hierarchal list):

1. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (OSWER 9355.4-24, Appendix C, 2002)
2. The Risk Assessment Information System (RAIS, Oak Ridge National Laboratory, http://rais.ornl.gov/)
3. Hazardous Substances Data Bank (National Library of Medicine, TOXNET, http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB)

Table 9
Site-Specific Soil Screening Level Calculations (SSLs) - AOC F
Hercules Research Center
Wilmington, Delaware

Constituent	Target Leachate Concentration (mg/L)*	C_w Target Leachate Conc * DAF (mg/L)	Koc/K_d** Soil-water partition coefficient (L/kg)	H' Dimensionless Henry's Law Constant	Site-Specific SSL (mg/kg)	Maximum Concentration (mg/kg)	Is Max Conc > SSL ?
4,4-DDD	2.80E-04	7.22E-04	1.34E+04	1.64E-04	9.67E+00	2.40E+00	No
4,4-DDT	2.00E-04	5.16E-04	3.52E+04	3.32E-04	1.82E+01	4.40E+00	No
Aldrin	3.90E-06	1.01E-05	3.28E+04	6.97E-03	3.30E-01	1.40E-03	No
alpha-BHC	1.10E-05	2.84E-05	1.65E+01	4.35E-04	4.73E-04	1.10E-04	No
Arsenic	4.20E-06	1.08E-05	2.90E+01	0.00E+00	3.16E-04	9.80E+00	Yes
Benzo(a)anthracene	3.00E-05	7.73E-05	5.33E+03	1.37E-04	4.12E-01	3.30E-01	No
Benzo(a)pyrene	3.00E-06	7.73E-06	1.37E+04	4.63E-05	1.06E-01	1.90E-01	Yes
Benzo(b)fluoranthene	3.00E-05	7.73E-05	1.65E+04	4.55E-03	1.27E+00	7.70E-01	No
beta-BHC	3.70E-05	9.54E-05	1.69E+01	3.05E-05	1.63E-03	4.00E-04	No
Carbazole	N/A	N/A	4.54E+01	6.26E-07	N/A	6.80E-02	No
Chromium	5.50E+01	1.42E+02	1.80E+06	0.00E+00	2.55E+08	1.02E+02	No
delta-BHC	3.70E-05	9.54E-05	1.43E+01	5.74E-04	1.39E-03	3.30E-04	No
Dibenz(a,h)anthracene	3.00E-06	7.73E-06	5.09E+04	6.03E-07	3.94E-01	1.10E-01	No
Dieldrin	4.20E-06	1.08E-05	2.87E+02	6.19E-04	3.11E-03	5.80E-03	Yes
Dinoseb	3.70E-02	9.54E-02	4.75E+01	1.86E-05	4.55E+00	4.40E-02	No
gamma-BHC (Lindane)	5.20E-05	1.34E-04	1.43E+01	5.74E-04	1.95E-03	8.90E-02	Yes
Indeno(1,2,3-cd)pyrene	3.00E-05	7.73E-05	4.65E+04	6.65E-05	3.60E+00	3.80E-01	No
Manganese	7.30E-01	1.88E+00	6.50E+01	0.00E+00	1.23E+02	7.25E+02	Yes
Methylene Chloride	4.10E-03	1.06E-02	1.57E-01	8.98E-02	4.21E-03	9.00E-03	Yes
Vanadium	3.70E-02	9.54E-02	1.00E+03	0.00E+00	9.54E+01	8.44E+01	No

Mixing Zone Depth, $d = (0.0112*L^2)^{0.5} + da \{1 - \exp(-1*L*I)/(K*i*da)\}$

d = 7.41

Dilution Attenuation Factor, DAF = 1 + (K*i*d)/(I*L)

DAF = 2.58

Where:

L =	49	Source Length parallel to ground water flow (m)
d_a =	2.74	Aquifer thickness (m)
I =	0.18	Infiltration Rate (m/yr) [default]
K =	233.7	Hydraulic Conductivity (m/yr)
i =	0.008	Hydraulic Gradient (m/m)

Soil Screening Level = C_w * [K_d + (Qw + Qa*H')/(P)]

Where:

Qw =	0.300	Water Filled Porosity (L_{water}/L_{soil}) [default]
Qa =	0.700	Air filled Porosity (L_{air}/L_{soil}) [default]
P =	1.50	Dry Soil Bulk Density (kg/L) [default]

*Region III Risk-Based Concentration for tap water (6 April 2007)

** For organics Kd = Koc * foc, where foc = **0.0134** Fraction Organic Carbon [site-specific, measured]

H' = H * 41 (where 41 is a conversion factor)

Chemical-specific values for Koc, Kd and H' source (hierarchal list):

1. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (OSWER 9355.4-24, Appendix C, 2002)
2. The Risk Assessment Information System (RAIS, Oak Ridge National Laboratory, http://rais.ornl.gov/)
3. Hazardous Substances Data Bank (National Library of Medicine, TOXNET, http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB)

Table 10
Site-Specific Soil Screening Level Calculations (SSLs) - SWMU 4
Hercules Research Center
Wilmington, Delaware

Constituent	**Target Leachate Concentration (mg/L)***	**C_w Target Leachate Conc * DAF (mg/L)**	**Koc/K_d** ** Soil-water partition coefficient (L/kg)**	**H' Dimensionless Henry's Law Constant**	**Site-Specific SSL (mg/kg)**	**Maximum Concentration (mg/kg)**	**Is Max Conc > SSL ?**
1,2-Dichloropropane	1.60E-04	6.85E-04	5.86E-01	1.15E-01	5.75E-04	5.00E-03	Yes
Antimony	1.50E-02	6.42E-02	4.50E+01	0.00E+00	2.90E+00	1.74E+00	No
Arsenic	4.20E-06	1.80E-05	2.90E+01	0.00E+00	5.25E-04	1.04E+01	Yes
Barium	7.30E+00	3.12E+01	4.10E+01	0.00E+00	1.29E+03	3.84E+02	No
Benzene	3.40E-04	1.46E-03	7.89E-01	2.28E-01	1.59E-03	5.55E+01	Yes
Benzo(a)anthracene	3.00E-05	1.28E-04	5.33E+03	1.37E-04	6.85E-01	4.70E-02	No
Benzo(a)pyrene	3.00E-06	1.28E-05	1.37E+04	4.63E-05	1.75E-01	4.30E-02	No
Benzo(b)fluoranthene	3.00E-05	1.28E-04	1.65E+04	4.55E-03	2.12E+00	8.50E-02	No
Chlorobenzene	9.00E-02	3.85E-01	2.93E+00	1.52E-01	1.23E+00	1.14E+02	Yes
Chloroform	1.50E-04	6.42E-04	5.33E-01	1.50E-01	5.16E-04	2.00E-03	Yes
Chromium	5.50E+01	2.35E+02	1.80E+06	0.00E+00	4.24E+08	5.27E+01	No
Manganese	7.30E-01	3.12E+00	6.50E+01	0.00E+00	2.04E+02	7.07E+02	Yes
Methylene Chloride	4.10E-03	1.75E-02	1.57E-01	8.98E-02	7.00E-03	2.60E-02	Yes
Naphthalene	6.50E-03	2.78E-02	2.68E+01	1.98E-02	7.51E-01	1.60E-01	No
Selenium	1.80E-01	7.70E-01	5.00E+00	0.00E+00	4.01E+00	1.75E+00	No
Tetrachloroethene	1.00E-04	4.28E-04	2.08E+00	7.54E-01	1.13E-03	6.00E-03	Yes
Thallium	2.60E-03	1.11E-02	7.10E+01	0.00E+00	7.92E-01	3.40E+00	Yes
Trichloroethene	2.60E-05	1.11E-04	2.22E+00	4.22E-01	2.92E-04	4.00E-03	Yes
Vanadium	3.70E-02	1.58E-01	1.00E+03	0.00E+00	1.58E+02	1.02E+02	No
Xylene (total)	2.10E-01	8.99E-01	5.94E+00	2.71E-01	5.63E+00	2.20E-01	No

Mixing Zone Depth, d = (0.0112*L^^{2})^$^{0.5}$ + da {1 - exp(-1*L*I)/(K*i*da)}

d = 6.96

Dilution Attenuation Factor, DAF = 1 + (K*i*d)/(I*L)

DAF = 4.28

Where:

L =	49	Source Length parallel to ground water flow (m)
d_a =	6.16	Aquifer thickness (m)
I =	0.18	Infiltration Rate (m/yr) [default]
K =	138.0	Hydraulic Conductivity (m/yr)
i =	0.030	Hydraulic Gradient (m/m)

Soil Screening Level = C_w * [K_d + (Qw + Qa*H')/(P)]

Where:

Qw =	0.300	Water Filled Porosity (L_{water}/L_{soil}) [default]
Qa =	0.700	Air filled Porosity (L_{air}/L_{soil}) [default]
P =	1.50	Dry Soil Bulk Density (kg/L) [default]

*Region III Risk-Based Concentration for tap water (6 April 2007)

** For organics Kd = Koc * foc, where foc = **0.0134** Fraction Organic Carbon [site-specific, measured]

H' = H * 41 (where 41 is a conversion factor)

<u>Chemical-specific values for Koc, Kd and H' source (hierarchal list):</u>

1. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (OSWER 9355.4-24, Appendix C, 2002)
2. The Risk Assessment Information System (RAIS, Oak Ridge National Laboratory, http://rais.ornl.gov/)
3. Hazardous Substances Data Bank (National Library of Medicine, TOXNET, http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB)

Table 11
Site-Specific Soil Screening Level Calculations (SSLs) - SWMU 7
Hercules Research Center
Wilmington, Delaware

Constituent	**Target Leachate Concentration (mg/L)***	**C_w Target Leachate Conc * DAF (mg/L)**	**Koc/K_d** Soil-water partition coefficient (L/kg)**	**H' Dimensionless Henry's Law Constant**	**Site-Specific SSL (mg/kg)**	**Maximum Concentration (mg/kg)**	**Is Max Conc > SSL ?**
Total TCDD TEC	4.50E-10	6.46E-10	1.96E+03	2.04E-03	1.26E-06	5.39E-03	Yes

Mixing Zone Depth, d = $(0.0112*L^2)^{0.5}$ + da {1 - exp(-1*L*I)/(K*i*da)}

d = 4.18

Dilution Attenuation Factor, DAF = 1 + (K*i*d)/(I*L)

DAF = 1.43

Where:

L =	15	Source Length parallel to ground water flow (m)
d_a =	2.67	Aquifer thickness (m)
I =	0.18	Infiltration Rate (m/yr) [default]
K =	311.6	Hydraulic Conductivity (m/yr)
i =	0.0009	Hydraulic Gradient (m/m)

Soil Screening Level = C_w * [K_d + (Qw + Qa*H')/(P)]

Where:

Qw =	0.300	Water Filled Porosity (L_{water}/L_{soil}) [default]
Qa =	0.700	Air filled Porosity (L_{air}/L_{soil}) [default]
P =	1.50	Dry Soil Bulk Density (kg/L) [default]

*Region III Risk-Based Concentration for tap water (6 April 2007)

** For organics Kd = Koc * foc, where foc = **0.0134** Fraction Organic Carbon [site-specific, measured]

H' = H * 41 (where 41 is a conversion factor)

<u>Chemical-specific values for Koc, Kd and H' source (hierarchal list):</u>

1. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (USEPA, 9355.4-24, Appendix C, 2002)
2. The Risk Assessment Information System (RAIS, Oak Ridge National Laboratory, http://rais.ornl.gov/)
3. Hazardous Substances Data Bank (National Library of Medicine, TOXNET, http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB)

[default] - All default values taken from Soil Screening Guidance: Users Guide (USEPA, 9355.4-23, 1996)

Table 12
Site-Specific Soil Screening Level Calculations (SSLs) - SWMU 9D
Hercules Research Center
Wilmington, Delaware

Constituent	**Target Leachate Concentration (mg/L)***	**C_w Target Leachate Conc * DAF (mg/L)**	**Koc/K_d** ** **Soil-water partition coefficient (L/kg)**	**H' Dimensionless Henry's Law Constant**	**Site-Specific SSL (mg/kg)**	**Maximum Concentration (mg/kg)**	**Is Max Conc > SSL ?**
4,4-DDD	2.80E-04	9.31E-04	1.34E+04	1.64E-04	1.25E+01	8.40E+00	No
4,4-DDE	2.00E-04	6.65E-04	5.99E+04	8.61E-04	3.98E+01	2.60E+00	No
4,4-DDT	2.00E-04	6.65E-04	3.52E+04	3.32E-04	2.34E+01	3.90E+01	Yes
Aldrin	3.90E-06	1.30E-05	3.28E+04	6.97E-03	4.26E-01	2.90E-03	No
alpha-BHC	1.10E-05	3.66E-05	1.65E+01	4.35E-04	6.10E-04	5.00E-04	No
alpha-Chlordane	1.90E-04	6.32E-04	1.61E+03	1.99E-03	1.02E+00	5.00E-02	No
Aroclor 1254	3.30E-05	1.10E-04	1.01E+03	1.16E-02	1.11E-01	2.87E+00	Yes
Arsenic	4.20E-06	1.40E-05	2.90E+01	0.00E+00	4.08E-04	9.58E+01	Yes
Barium	7.30E+00	2.43E+01	4.10E+01	0.00E+00	1.00E+03	5.30E+02	No
beta-BHC	3.70E-05	1.23E-04	1.69E+01	3.05E-05	2.10E-03	7.70E-03	Yes
Cadmium	1.80E-02	5.99E-02	7.50E+01	0.00E+00	4.50E+00	3.50E+00	No
Chromium	5.50E+01	1.83E+02	1.80E+06	0.00E+00	3.29E+08	5.20E+02	No
delta-BHC	3.70E-05	1.23E-04	1.43E+01	5.74E-04	1.79E-03	1.40E-03	No
Dieldrin	4.20E-06	1.40E-05	2.87E+02	6.19E-04	4.01E-03	2.10E-02	Yes
gamma-BHC (Lindane)	5.20E-05	1.73E-04	1.43E+01	5.74E-04	2.51E-03	3.70E-04	No
Heptachlor Epoxide	7.40E-06	2.46E-05	1.11E+03	3.90E-04	2.74E-02	2.30E-03	No
Manganese	7.30E-01	2.43E+00	6.50E+01	0.00E+00	1.58E+02	1.60E+03	Yes
Silver	1.80E-01	5.99E-01	8.30E+00	0.00E+00	5.09E+00	2.90E+00	No
Toxaphene	6.10E-05	2.03E-04	3.44E+03	2.46E-04	6.99E-01	6.90E-01	No
Vanadium	3.70E-02	1.23E-01	1.00E+03	0.00E+00	1.23E+02	2.40E+02	Yes

Mixing Zone Depth, d = (0.0112*L^^{2})^$^{0.5}$ + da {1 - exp(-1*L*I)/(K*i*da)}

d = 2.34

Dilution Attenuation Factor, DAF = 1 + (K*i*d)/(I*L)

DAF = 3.33

Where:

L =	15	Source Length parallel to ground water flow (m)
d_a =	1.46	Aquifer thickness (m)
I =	0.18	Infiltration Rate (m/yr) [default]
K =	39	Hydraulic Conductivity (m/yr)
i =	0.070	Hydraulic Gradient (m/m)

Soil Screening Level = C_w * [K_d + (Qw + Qa*H')/(P)]

Where:

Qw =	0.300	Water Filled Porosity (L_{water}/L_{soil}) [default]
Qa =	0.700	Air filled Porosity (L_{air}/L_{soil}) [default]
P =	1.50	Dry Soil Bulk Density (kg/L) [default]

*Region III Risk-Based Concentration for tap water (6 April 2007)

** For organics Kd = Koc * foc, where foc = **0.0134** Fraction Organic Carbon [site-specific, measured]

H' = H * 41 (where 41 is a conversion factor)

Chemical-specific values for Koc, Kd and H' source (hierarchal list):

1. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (OSWER 9355.4-24, Appendix C, 2002)
2. The Risk Assessment Information System (RAIS, Oak Ridge National Laboratory, http://rais.ornl.gov/)
3. Hazardous Substances Data Bank (National Library of Medicine, TOXNET, http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB)

Table 13
Site-Specific Soil Screening Level Calculations (SSLs) - SWMU 12
Hercules Research Center
Wilmington, Delaware

Constituent	Target Leachate Concentration (mg/L)*	C_w Target Leachate Conc * DAF (mg/L)	Koc/K_d** Soil-water partition coefficient (L/kg)	H' Dimensionless Henry's Law Constant	Site-Specific SSL (mg/kg)	Maximum Concentration (mg/kg)	Is Max Conc > SSL ?
2-Methylnaphthalene	2.40E-02	3.93E-02	1.14E+02	1.07E-02	4.48E+00	1.85E+00	No
4,4-DDT	2.00E-04	3.27E-04	3.52E+04	3.32E-04	1.15E+01	1.80E-01	No
Aldrin	3.90E-06	6.38E-06	3.28E+04	6.97E-03	2.10E-01	8.80E-04	No
alpha-Chlordane	1.90E-04	3.11E-04	1.61E+03	1.99E-03	5.00E-01	6.15E-02	No
Aroclor 1254	3.30E-05	5.40E-05	1.01E+03	1.16E-02	5.47E-02	6.80E+00	Yes
Arsenic	4.20E-06	6.87E-06	2.90E+01	0.00E+00	2.01E-04	7.70E+01	Yes
Barium	7.30E+00	1.19E+01	4.10E+01	0.00E+00	4.92E+02	6.44E+02	Yes
Benzo(a)anthracene	3.00E-05	4.91E-05	5.33E+03	1.37E-04	2.62E-01	2.30E-01	No
Benzo(a)pyrene	3.00E-06	4.91E-06	1.37E+04	4.63E-05	6.71E-02	2.00E-01	Yes
Benzo(b)fluoranthene	3.00E-05	4.91E-05	1.65E+04	4.55E-03	8.09E-01	5.25E-01	No
Cadmium	1.80E-02	2.95E-02	7.50E+01	0.00E+00	2.22E+00	1.60E+00	No
Carbazole	N/A	N/A	4.54E+01	6.26E-07	N/A	7.00E-02	No
Carbon Tetrachloride	1.60E-04	2.62E-04	2.33E+00	1.25E+00	8.16E-04	2.00E-03	Yes
Chloroform	1.50E-04	2.46E-04	5.33E-01	1.50E-01	1.97E-04	2.00E-03	Yes
Chromium	5.50E+01	9.00E+01	1.80E+06	0.00E+00	1.62E+08	4.37E+01	No
Dibenz(a,h)anthracene	3.00E-06	4.91E-06	5.09E+04	6.03E-07	2.50E-01	4.30E-02	No
Dieldrin	4.20E-06	6.87E-06	2.87E+02	6.19E-04	1.97E-03	2.25E-02	Yes
gamma-BHC (Lindane)	5.20E-05	8.51E-05	1.43E+01	5.74E-04	1.24E-03	1.60E-03	Yes
Manganese	7.30E-01	1.19E+00	6.50E+01	0.00E+00	7.79E+01	2.52E+03	Yes
Methylene Chloride	4.10E-03	6.71E-03	1.57E-01	8.98E-02	2.68E-03	1.60E-02	Yes
Naphthalene	6.50E-03	1.06E-02	2.68E+01	1.98E-02	2.87E-01	1.15E+00	Yes
N-Nitrosodiphenylamine	1.40E-02	2.29E-02	1.73E+01	2.05E-04	4.01E-01	3.20E+00	Yes
Selenium	1.80E-01	2.95E-01	5.00E+00	0.00E+00	1.53E+00	1.90E+00	Yes
Silver	1.80E-01	2.95E-01	8.30E+00	0.00E+00	2.50E+00	6.20E+00	Yes
Thallium	2.60E-03	4.26E-03	7.10E+01	0.00E+00	3.03E-01	2.50E-01	No
Trichloroethene	2.60E-05	4.26E-05	2.22E+00	4.22E-01	1.12E-04	2.70E-02	Yes
Vanadium	3.70E-02	6.06E-02	1.00E+03	0.00E+00	6.06E+01	3.54E+02	Yes

Mixing Zone Depth, $d = (0.0112*L^2)^{0.5} + da\{1 - \exp(-1*L*I)/(K*i*da)\}$

d = 5.86

Dilution Attenuation Factor, DAF = 1 + (K*i*d)/(I*L)

DAF = 1.64

Where:

L =	14	Source Length parallel to ground water flow (m)
d_a =	5.25	Aquifer thickness (m)
I =	0.18	Infiltration Rate (m/yr) [default]
K =	311.6	Hydraulic Conductivity (m/yr)
i =	0.0009	Hydraulic Gradient (m/m)

Soil Screening Level = C_w * [K_d + (Qw + Qa*H')/(P)]

Where:

Qw =	0.300	Water Filled Porosity (L_{water}/L_{soil}) [default]
Qa =	0.700	Air filled Porosity (L_{air}/L_{soil}) [default]
P =	1.50	Dry Soil Bulk Density (kg/L) [default]

*Region III Risk-Based Concentration for tap water (6 April 2007)

** For organics Kd = Koc * foc, where foc = **0.0134** Fraction Organic Carbon [site-specific, measured]

H' = H * 41 (where 41 is a conversion factor)

<u>Chemical-specific values for Koc, Kd and H' source (hierarchal list):</u>

1. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (OSWER 9355.4-24, Appendix C, 2002)
2. The Risk Assessment Information System (RAIS, Oak Ridge National Laboratory, http://rais.ornl.gov/)
3. Hazardous Substances Data Bank (National Library of Medicine, TOXNET, http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB)